

**TECHNICAL MANUAL**

**INSPECTION AND REPAIR OF**

**AIRCRAFT**

**INTEGRAL TANKS,**

**AND**

**FUEL CELLS**

(ATOS)

**BASIC AND ALL CHANGES HAVE BEEN MERGED TO MAKE THIS A COMPLETE PUBLICATION**

DISTRIBUTION STATEMENT - Approved for public release; distribution is unlimited.

Published under authority of the Secretary of the Air Force

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**30 NOVEMBER 1994**

**CHANGE 10 - 20 AUGUST 2001**

**LIST OF EFFECTIVE PAGES**

NOTE: The portion of the text affected by the changes is indicated by a vertical line in the outer margins of the page. Changes to illustrations are indicated by miniature pointing hands. Changes to wiring diagrams are indicated by shaded areas.

**Dates of issue for original and changed pages are:**

Original .....	0.....	30 November 1994	Change.....	7.....	12 March 1999
Change.....	1.....	16 February 1996	Change.....	8.....	13 August 1999
Change.....	2.....	7 June 1996	Change.....	9.....	23 April 2001
Change.....	3.....	6 September 1996	Change.....	10.....	20 August 2001
Change.....	4.....	31 January 1997			
Change.....	5.....	12 May 1997			
Change.....	6.....	23 January 1998			

TOTAL NUMBER OF PAGES IN THIS PUBLICATION IS 220, CONSISTING OF THE FOLLOWING:

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## SECTION I

### INTRODUCTION

#### 1-1 PURPOSE.

This manual establishes USAF policy for the maintenance of aircraft fuel tanks and cells. Included in this manual are general requirements for preparation of an aircraft for fuel systems and component maintenance and inspection. The requirements of this manual are applicable to all aircraft in the AF inventory. Procedures requiring special equipment, facilities or extraordinary safety precautions are not included in this manual.

#### 1-2 GENERAL.

The manual is divided into the following sections: Introduction, Safety, Health and Environmental Requirements, Facilities, Leak Classification and Temporary Repairs, Preparation for Maintenance, Integral Tanks, Fuel Cells, Equipment and Materials, and Glossary.

1-2.1 Section I provides authority for publication of the manual, summarizes each section, summarizes the duties, qualifications and training for personnel and organizations involved in fuel systems repair, and provides for resolution when the requirements of this manual conflict with other Air Force documents.

1-2.2 Section II provides safety, health, and environmental requirements necessary to perform fuel systems repair.

1-2.3 Section III provides a brief description of the areas and facilities required for fuel systems maintenance. This includes Category I, II, and III facilities, and open areas.

1-2.4 Section IV provides information for categorizing fuel leaks, documenting leaks in the aircraft records, and applying temporary repairs to aircraft fuel leaks.

1-2.5 Section V provides instructions preparing an aircraft for maintenance. Included are procedures for fluid purge, air purge, inerting, ventilating open tanks, draining, and depuddling aircraft. Removal inspection and replacement of fuel foam is included in this section.

1-2.6 Section VI describes the various techniques for inspecting and repairing integral tanks. Procedures common to all levels of maintenance or not requiring special facilities or extraordinary safety precautions are detailed. Procedures requiring special equipment, facilities or extraordinary safety precautions are not included in this manual.

1-2.7 Section VII describes the various techniques for inspecting and repairing fuel cells.

1-2.8 Section VIII lists the equipment and material necessary to perform the inspection and repair procedures described in this manual.

1-2.9 Glossary contains definitions of both common words and words/phrases peculiar to fuel systems repair.

#### 1-3 REPAIR RESPONSIBILITY.

Field level maintenance organizations shall be responsible for accomplishing normal fuel tank maintenance and repair. If specialized personnel and/or equipment and facilities are required but are not available at the organizational level, assistance shall be requested from the appropriate area support ALC in accordance with T.O. 00-25-107, MAJCOM functional managers, the Weapon System Manager and the OPR for this technical order.

#### 1-4 AUTHORITY.

The provisions of this manual are directive in nature and are applicable to all military and civilian personnel directly or indirectly concerned with fuel systems maintenance. AFOSH 127-100 provides authority for this manual to contain safety and health requirements for: fuel cell/tank maintenance, fuel system maintenance, fuel system repair facilities, and related areas.

1-4.1 This manual is written primarily to the skills, procedures, equipment, materials and facilities common throughout the Air Force. The manual is applicable to all levels of aircraft maintenance. This manual is applicable to agencies and businesses performing work on USAF aircraft when this manual is referenced in a contractual document or statement of work. In addition to the requirements of this manual, civilian contractors are responsible for meeting the requirements of the applicable National Fire Protection Association (NFPA) and Occupational Safety and Health Administration (OSHA), in addition to other laws (federal, state, and local).

1-4.2 The word SHALL means that the requirement is mandatory.

1-4.3 The word WILL is used to express declaration of purpose.

1-4.4 The word SHOULD is used to express a nonmandatory desire or preferred method of accomplishment.

1-4.5 The word MAY is used to express an acceptable means of accomplishment.

1-5 CONFLICT.

Every attempt is made to keep this manual current with all safety, health and environmental directives. When this manual is in conflict with an AFOSH, OSHA or other federal directive an AFTO 22 shall be submitted in accordance with T.O. 00-5-1. When the requirements of this manual are in conflict with state or local directives, resolution shall be sought through that agency with assistance from the MAJCOM functional manager for fuel system maintenance. When this manual conflicts with other general series or policy and procedures technical orders the requirements of this manual should take precedence. When this manual conflicts weapon system or commodity technical orders the requirements of the weapon system or commodity technical order take precedence for all non-safety, non-health, and non-facility related issues.

1-5.1 The general safety and health and maintenance procedures of this manual can be applied to removable metal tanks, benson, ferry and external

removable/jettisonable tanks. Specific procedures for these types of tanks are generally included in the commodity T.O. for the tank. Repair of oil, water, and alcohol integral tanks and cells can be performed using the requirements and procedures of this manual.

1-6 PERSONNEL.

Information concerning the responsibilities, qualifications and training requirements of this manual are summarized in the following paragraphs. This is provided for informational purposes only. For complete requirements refer to the text of this technical order.

1-6.1 As the Air Force reorganizes, various individual's functions change, as do their duty titles. The most common or accepted position titles are provided for military and civil service members of the Department of the Air Force. Contractors performing work to the requirements of this manual are expected to meet the same requirements of their Department of the Air Force counterparts. Table 1-1 is provided as guidance to determining Civil Service equivalents at Air Logistics Centers to military positions:

Table 1-1. Position Equivalents

<u>MILITARY</u>		<u>CIVIL SERVICE</u>	
■	Logistics Group Commander (LG/CC), Deputy Commander Maintenance (DCM), Maintenance Group Commander (MG/CC)	Production Division Chief for each Directorate	
	AFSC 2A6X4 AFSC 454X3	WG-4361-XX or WG-8801-XX or WG-8852-XX or WG-8268-XX or Other WG Series as designated by local management	
	Fuel Element Chief, Fuel Shop Chief	First Level Fuel Shop Supervisor	
1-6.2 The responsibilities, qualifications and training requirements for all personnel directly or indirectly responsible for fuel systems maintenance are as follows: This is provided for informational purposes only. For complete requirements refer to the text of this technical order.		b. shall be responsible for all fuel tank/cell entries	
1-6.2.1 <u>LG/CC - DCM - Production Division Chief</u>		c. shall sign the Entry Authority Authorization Letter	
1-6.2.1.1 <u>Responsibilities.</u>		d. shall designate open fuel system repair areas as necessary	
a. shall appoint an Entry Authority (usually fuel element chief)		e. shall ensure technical orders for equipment used in fuel system repair areas and facilities are available and followed	

- f. shall ensure all safety, health, and environmental regulations are complied with
- g. should coordinate on material and equipment substitutions
- h. may, when authorized, substitute non-2A6X4 personnel for attendant
- i. may, when authorized, coordinate on waiver of certain safety and health requirements

**1-6.2.2 Entry Authority/Alternate Entry Authority.** In the absence of or when otherwise authorized by the Entry Authority the Alternate Entry Authority will perform the duties of the Entry Authority.

**1-6.2.2.1 Responsibilities.**

- a. shall complete and sign each Field Permit
- b. shall designate an Alternate Entry Authority
- c. shall designate a fuel tank entry chief
- d. shall ensure entries are conducted using safety practices and procedures of this manual
- e. shall ensure entrants are qualified
- f. shall ensure attendants are qualified and available
- g. shall ensure the equipment monitor/runner is trained and available when required
- h. shall assist in developing severe weather shut-down plan
- i. shall provide guidance on PPE for all entries
- j. shall assist in developing rescue plan
- k. shall never permit entry into an IDLH atmosphere
- l. shall establish a system for controlling tank entries
- m. shall only issue field permits when conditions of Entry Authority Authorization Letter are met. Will amend or reissue field permit as necessary
- n. will help develop training plans for fuel tank entries
- o. may authorize attendant to monitor multiple tanks
- p. may eliminate equipment monitor/runner in selected circumstances

**1-6.2.3 Entrant (2A6X4 or civilian equivalent)**

**1-6.2.3.1 Responsibilities.**

- a. shall be responsible for complying with entry permit
- b. shall obey instructions from attendant

**1-6.2.4 Entrant (non-2A6X4 or civilian equivalent)**

**1-6.2.4.1 Responsibilities.**

- a. shall be responsible for complying with entry permit
- b. shall obey instructions from attendant

**1-6.2.5 Attendant**

**1-6.2.5.1 Responsibilities.**

- a. shall have overall responsibility for monitoring the entry area
- b. shall alert equipment monitor/runner prior to initiating rescue
- c. shall limit entry to those authorized
- d. shall order evacuation of tank as necessary
- e. may, when authorized, monitor multiple tanks
- f. may be part of rescue team

**1-6.2.6 Equipment Monitor/Runner**

**1-6.2.6.1 Responsibilities.**

- a. shall summon rescue team when required
- b. shall monitor equipment
- c. shall remain in immediate area
- d. shall initiate rescue procedures when required
- e. may perform duties of attendant during rescue
- f. may monitor multiple tanks or aircraft
- g. may be part of rescue team
- h. may enter tank if qualified

**1-6.2.7 Rescue Team - Extraction Team**

**1-6.2.7.1 Responsibilities.**

- a. Extract entrant from tank
- b. administer buddy care

Table 1-2. Summary of Qualifications and Training for confined Space Entry Personnel

	ENTRY * AUTHORITY	ENTRANT * 2A6X4	ENTRANT * NON2A6X4	ATTENDANT	EXTRACT * TEAM	EQUIPMENT * MONITOR
CPR	X	X		X	X	
MEDICAL	X	X	X	X	X	
RESPIRATOR (Qualified)	X	X	X		X	
TESTING CONFINED SPACES (Atmosphere)	X	X		X	X	
SELF AID/BUDDY CARE	X	X			X	
HAZARD COMMUNICATION	X	X	X			
TANK FAMILIARIZATION	X	X	X	X	X	
SELF RESCUE	X	X	X			
CONFINED SPACE HAZARDS	X	X	X	X	X	X
RESCUE PLAN	X	X	X	X	X	X
USE OF SHOP EQUIPMENT	X	X				X
USE OF RESPIRATORS	X	X	X	X	X	
USE OF OTHER PPE	X	X	X		X	
USE OF COMMUNICATIONS EQUIPMENT	X	X	X			
RECOGNIZING EXPOSURE TO CHEMICALS, SOLVENTS, AND FUELS	X	X	X	X	X	

#### 1-6.2.8 Fuel Element Chief- First Level Supervisor

##### 1-6.2.8.1 Responsibilities.

a. shall assist in developing rescue plan

b. shall implement severe weather shut-down plan

c. shall ensure safety, health, and environmental directives are complied with

d. will usually be the entry authority

1-6.2.9 Quality Assurance. Quality control personnel who will perform evaluations shall have either completed a fuel system repair school or have received training from the Fuel Element Shop Chief. The local training shall cover safety equipment, grounding, bonding, purging procedures, and depuddling operations. Training or recertification shall be conducted annually.

1-6.2.9.1 Responsibilities.

- a. provides task evaluation ensures compliance with T.O. 1-1-3. Applicable aircraft TOs, and safety/health standards.

1-6.2.10 Ground Safety Office

1-6.2.10.1 Responsibilities.

- a. should provide training on subject matter for which they have expertise
- b. shall assist in developing rescue plan
- c. shall coordinate on Entry Authority Authorization Letter
- d. coordinate on equipment substitutions
- e. shall coordinate on approval of open fuel system repair areas
- f. shall coordinate on approval of temporary fuel system repair areas

1-6.2.11 Bioenvironmental Services (BES) Office.

1-6.2.11.1 Responsibilities.

- a. should provide training on subject matter for which they have expertise
- b. shall coordinate on Entry Authority Authorization Letter
- c. should conduct periodic sampling to measure toxins
- d. shall provide guidance on PPE used for entries

1-6.2.12 Environment Management Office

1-6.2.12.1 Responsibilities.

- a. should provide training on subject matter for which they have to expertise

1-6.2.13 Fire Department

1-6.2.13.1 Responsibilities.

- a. should provide training on subject matter for which they have expertise

NOTE

These topics include but are not limited to use and positioning of fire

extinguishers, theory of combustion and NFPA codes. The fire department's capabilities should be an integral part of the rescue plan but not be listed as the initial response agency for emergencies.

- b. shall coordinate on Entry Authority Authorization Letter
- c. should assist in developing rescue plan
- d. shall coordinate on approval of open fuel system repair and temporary areas

1-6.2.14 Base Medical Officer

1-6.2.14.1 Responsibilities.

- a. should assist in developing rescue plan
- b. shall perform medical examinations in accordance with AFOSH standards
- c. should provide training on subject matter for which they have expertise

1-6.2.15 System Program Manager - System Program Office.

1-6.2.15.1 Responsibilities.

- a. shall keep Technical Orders current
- b. shall provide assistance to field and depot level maintenance activities
- c. may approve the use of alternate equipment
- d. may approve the use of alternate materials
- e. should coordinate equipment and material substitution with the MAJCOM functional manager and OPR for T.O. 1-1-3

1-6.2.16 Base Weather Officer

1-6.2.16.1 Responsibilities.

- a. shall assist in developing severe weather shut-down plan

1-6.2.17 Major Command Functional Manager

1-6.2.17.1 Responsibilities.

- a. should provide assistance to field and depot level maintenance activities
- b. may approve the use of alternate equipment
- c. may approve the use of alternate materials
- d. should coordinate equipment and material substitution with the SPM and OPR for T.O. 1-1-3

## T.O. 1-1-3

### 1-6.2.18 Office of Primary Responsibility for T.O. 1-1-3.

#### 1-6.2.18.1 Responsibilities.

- a. shall keep this technical order current with applicable safety and health directives
- b. should provide assistance to field, depot and contractor maintenance activities
- c. may approve the use of alternate equipment
- d. may approve the use of alternate materials
- e. should coordinate equipment and material substitution with the MAJCOM functional manager and SPMs

## SECTION II

### SAFETY, HEALTH, AND ENVIRONMENTAL REQUIREMENTS

#### 2-1 PURPOSE.

This section contains the safety, health, and environmental requirements necessary to conduct fuel systems maintenance with special emphasis on the requirements for tank and cell maintenance. This section covers personnel, facilities, equipment, and aircraft.

#### 2-2 GENERAL.

2-2.1 The provisions of this section are minimum requirements for average conditions. These provisions apply to fuel systems repair personnel and non-fuel systems repair personnel (for example: electricians, safety, and supervisory personnel). The requirements of this section assume a single aircraft is in the facility. For guidance on working more than one aircraft contact the appropriate base agencies, e.g. LG/CC, fire department, and ground safety.

2-2.2 Certain hazards are present during fuel systems maintenance. The presence of hazards is normal and if precautionary measures are taken there will be no increased risk associated with the maintenance operations. Cooperation is required from all personnel to cope with conditions presented. Deviations shall not be permitted from safety practices which increase the risk to the worker, aircraft, or facility. Supervisory personnel shall ensure all equipment is maintained in good working order and that personnel adhere to the requirements of this section.

#### 2-2.3 TRAINING REQUIREMENTS

2-2.3.1 Mishaps do not happen. Mishaps are caused by deviation from accepted practice, thus, mishaps are preventable. Proper safety instruction and training are essential to an accident free work environment.

2-2.3.2 All personnel (fuel and non-fuel) engaged in activities outlined in this manual shall be fully trained in the following (in addition to the training required for specific duties, e.g., attendant, emergency response team):

- a. Hazardous characteristics of the materials being used
- b. Hazard communications
- c. Use and limitations of the equipment being used
- d. Fuel system/tank familiarization

e. Use of personal protective equipment

f. How to protect personnel, aircraft, equipment and the environment from hazards encountered

2-2.3.3 Training and certification are required prior to permitting an employee to enter a tank/cell. Training and recertification shall be accomplished annually.

2-2.3.4 Associated maintenance shops shall have a sufficient core of trained and certified personnel (that are confined space entry qualified) to meet work requirements with minimal delay.

2-2.3.5 Quality Assurance personnel who will perform evaluations shall have either completed a fuel system repair school or have received training from the Fuel Element Shop Chief. The local training shall cover safety, equipment, grounding, bonding, purging procedures, and depuddling operations. Training or recertification shall be conducted annually.

2-2.3.6 Training will be provided by qualified individuals. Lesson plans or training outlines shall be approved by the responsible LG/CC, Fuel Element Chief, Safety Office, BES, Fire Department, and Environmental Management office (except Confined Space Training Plan) as applicable.

#### 2-3 ASSUMPTIONS AND ALTERNATIVES.

Some fuel cell/tank inspection and maintenance is accomplished without fuel or other flammable materials being present. In these cases the LG/CC may, with coordination and concurrence from ground safety, BES, and the fire department, rule that certain requirements of this section may be waived (the requirement for a permit entry system shall not be waived). This may be done after a review of the work procedures, an assessment of the work environment, and documentation of the absence of presumed hazards. The waiver is only applicable to requirements originating in this manual and is not extendable to requirements originating in weapon system technical orders, OSHA documents, and AFOSH documents.

#### 2-4 HAZARDS PRESENT.

2-4.1 STATIC ELECTRICITY. Static electricity is frequently generated when two unlike materials are brought into contact and then separated. Some common means of generating static charges

are; a person removing clothing, dust blowing across a surface, or liquid flowing through a pipe. The most practical method to protect against static charge buildup is to dissipate the static charges through proper connections to the ground. All personnel approaching an aircraft for fuel systems maintenance shall touch a static discharge plate or grounding point to remove static electricity.

#### 2-4.2 CONFINED SPACES AND ENCLOSED AREAS.

2-4.2.1 Confined spaces create a unique hazard due to limited entry/exit points and potential atmospheric hazards. To limit the risk associated with entry the confined space shall be assessed for hazards. Entry to the space shall be limited to authorized individuals and rescue procedures shall be in place prior to any entry. To prevent accidental death or injury from entrapment in confined spaces the requirements of this section and the applicable AFOSH standards shall be followed.

2-4.2.2 Some aircraft have tanks which are separated into multiple compartments. For the purposes of this TO each compartment will be treated as an individual tank. When air purging, each compartment will be purged and depuddled, to the extent necessary, before opening the next compartment. The LEL of the compartment will usually rise when the access door to another compartment is opened. If the LEL does not return to entry safe levels after 10 minutes, or exceeds 20 percent, the tank shall be evacuated until the concentration of fuel vapors is 10% LEL or less.

2-4.2.3 For the purposes of this manual, enclosed areas will be treated the same as confined spaces except as noted in paragraph 2-8.4.1.a.

2-4.3 HOT WORK. Hot work (e.g. cutting, welding, soldering, or any other operation that can provide a possible source of ignition) will generate temperatures high enough to ignite fuel, solvents, and other materials present during fuel systems repair. Special care must be taken to eliminate the combustion hazard associated with hot work. Approval for hot work in confined spaces shall be obtained from the base fire department. To prevent accidental death, injury or damage to aircraft, the requirements of this manual and applicable AFOSH standards shall be followed.

2-4.4 CHEMICALS. Solvents, chemicals, and other products used to repair aircraft fuel tanks and cells may be classified as flammable or combustible depending on their flashpoint. In addition to the fire hazard these solvents, chemicals,

and products may contain toxic substances. To prevent ignition of or overexposure to these products, the requirements of this section and the applicable AFOSH standards shall be followed. A Material Safety Data Sheet (MSDS) shall be available for each solvent, chemical or product used. Manufacturer's warnings and cautions shall be observed. Contact the local BES for guidance on PPE to be used when working with solvents and chemicals.

2-4.5 RADAR AND COMMUNICATIONS SYSTEMS. Certain radar and communications systems, especially high powered ground based systems, are capable of producing peak power densities intense enough to cause unintentional ignition of volatile fuels when used in close proximity to fuel servicing, storage or maintenance areas. The base communication officer shall be contacted periodically to determine if equipment capable of producing such intensities is presently being used or future use is planned. Guidelines for separation distances are contained in TO 31Z-10-4. Assistance may be requested from the local BES office (OPR for radio frequency radiation program).

#### 2-4.6 FUELS.

2-4.6.1 Air Force aircraft fuels are classified as either combustible or flammable liquids. AVGAS and JP-4 have a large percentage of low flashpoint hydrocarbons and will create a readily ignitable vapor-air concentration at ambient temperatures. AVGAS and JP-4 are flammable liquids. JP-5 and JP-8 are comprised of a larger percentage of higher flash point hydrocarbons and do not as readily form flammable vapor-air concentrations at ambient temperatures. JP-5 and JP-8 are combustible liquids. At temperatures below the flashpoint fuels are not likely to generate sufficient vapors to form a vapor-air concentration in the lower explosive limit range. Military Specification fuels (JP-Series) require the use of antistatic additives. Commercial fuels (Jet-A, Jet-A1, Jet-B) do not have antistatic additives.

2-4.6.2 In addition to the fire hazard fuels also contain many toxic substances such as benzene, toluene and xylene. Exposure to relatively low levels of fuel may cause nausea or loss of appetite. Exposure to high levels of fuel may cause headaches, dizziness, euphoria, convulsions or death. To prevent ignition of or overexposure to aircraft fuel the requirements of this section and the applicable AFOSH standards shall be followed.

Table 2-1. Common Jet Fuel Properties and Additives

JET FUEL PROPERTIES					
	JP-4	JP-8	JET A-1	JET A	JP-5
FLASHPOINT °F	-20	100	100	100	140
FREEZE POINT °F	-72	-53	-53	-40	-51
FLAMM °F	-20 TO 80	100 - 170	100 - 170	100 - 170	140 - 220
LBS/GAL	6.3	6.7	6.7	6.7	6.8
VAPOR PRESSURE	2-3	NIL	NIL	NIL	NIL
AROMATICS %	25	25	20	20	25
BTU/GAL (TYPICAL)	118900	124500 (+4.7%)	124500	124500	126000 (+5.9%)
JET FUEL ADDITIVES					
	JP-4	JP-8	JET A-1	JET A	JP-5
FSH	YES	YES	NO*	NO*	YES
CORR/LUBR	YES	YES	NO*	NO*	YES
CONDUTIVITY	YES	YES	YES	NO*	NO
ANTI-OXIDANT	COND	COND	NO*	NO*	YES
METAL DETACT	OPT	OPT	NO*	NO*	OPT
TRACER	OPT	OPT	NO	NO	OPT
COND = IF HYDRO TREATED OPT = OPTION OF SUPPLIER * = APPROVED BUT NOT TYPICALLY USED					

**2-4.7 CLIMATIC CONDITIONS.** High winds (usually 30 kts/hr or higher), thunderstorms/lightning or other forms of severe weather can damage aircraft or injure personnel. Severe weather can cause power outages, create a hazard from wind blown materials, sand or equipment, create high levels of static electricity, cause water intrusion or cause other problems. Lightning may cause the ignition of fuel vapors or electrocution of personnel. Extremes in temperature can cause heat stress, freezing of skin and other injuries or illnesses. For guidance on performing fuel systems maintenance during periods of temperature extremes contact the local BES office.

**2-4.8 ENVIRONMENTAL HAZARDS.** Many of the operations in this manual use materials which generate hazardous waste or can damage the environment. Many of the solvents including those claiming to be biodegradable are capable of generating significant amounts of hazardous waste. The use of Ozone Depleting Substances (ODS) is being banned. Every effort has been made to

eliminate the use of ozone depleting substances to the maximum extent possible. Ozone depleting substances may only be used when no other alternative is available and then approval must be granted in accordance with Air Force policy. The local Environmental Management Office should be contacted for further information and guidance on this subject.

**2-4.9 ANCILLARY SYSTEMS.** Fire Suppression Systems, OBIGGS, and hydrazine systems require extreme caution. Refer to applicable aircraft technical manuals for more specific guidance.

## 2-5 MEDICAL REQUIREMENTS.

**2-5.1 PHYSICAL EXAMINATIONS.** Personnel to be assigned to fuel system repair, or non-fuel systems repair personnel who must enter fuel tanks and wear respirators shall receive a physical examination in accordance with AFOSH 161-17 prior to job placement. Personnel assigned shall have periodic examinations to permit early detection of possible detrimental effects resulting from

chronic exposures. The examination shall be conducted by the base medical service yearly. As a minimum the examination should include: health history, pulmonary function, visual acuity, physical examination, and additional tests as determined by the base medical officer based on personal exposure.

## 2-5.2 EMERGENCY TREATMENT.

2-5.2.1 Splashes or spills in the eyes may cause loss of sight. The eyes must be flushed immediately and repeatedly with fresh water. Medical treatment shall be obtained as soon as possible. Splashes to other areas of the body shall be rinsed with fresh water, medical attention shall be obtained if abnormal conditions or symptoms develop or if recommended on the MSDS.

2-5.2.2 Ingestion of fuel or other chemicals may cause death or illness. Personnel ingesting fuel or other chemicals shall be immediately taken to a medical facility for treatment. Do not induce vomiting unless authorized by medical personnel.

2-5.2.3 For treatment of other types of injury and illness contact base medical officer.

## 2-6 PROTECTIVE CLOTHING AND EQUIPMENT.

### 2-6.1 CLOTHING.

2-6.1.1 Outer Garments. Personnel performing maintenance in fuel systems repair areas/facilities shall wear approved clothing to eliminate the possibility of creating a static electricity discharge. Non-cotton outer garments shall be removed. Static-free, no pocket, velcro closure or non-sparking buttons, coveralls or approved sweat shirts and pants shall be worn. White is the preferred color for all clothing, however, other colors are acceptable. Clothing containing excessive dried sealant will be discarded. Clothing shall be cleaned as often as necessary to remove dirt and oil. Cotton or cotton blend sweat pants and sweat shirts are also approved outerwear. Care should be taken to ensure loose buttons do not snag on fuel system components and become torn loose.

2-6.1.2 Chemical Resistant Clothing. Local BES may require the use of chemical resistant clothing. This clothing shall be covered by approved outer garments to prevent discharge of static electricity. In general this clothing will increase the probability of heat stress.

2-6.1.3 Footwear. Personnel entering the fuel systems repair areas/facilities shall remove all footwear with exposed spark producing nails or metal plates on the walking surfaces. Clean shoes or boots with or without footwear covers may be

worn in tanks. Shoes or boots shall not be worn in fuel cells. Cotton or cotton blend socks shall be worn.

2-6.1.4 Gloves. Chemical resistant gloves or other locally approved gloves are required for depuddling fuel, application of cleaners/solvents and removal of explosion suppression foam. Cotton or surgical gloves may be worn for the application of sealants and adhesives. Hand creams and barrier creams are not considered suitable hand protection, but may be used under any approved glove.

2-6.1.5 Headcoverings. Hats or headcoverings should be worn when accomplishing internal curing type sealant repair. The headcovering will prevent scalp oils from contaminating aircraft surfaces and minimize the possibility of getting sealant in hair.

2-6.1.6 Knee and Elbow Pads. Neoprene rubber knee and elbow pads may be used for protection. Neoprene rubber mats may be laid in the cell/tank for cushioning and protection.

2-6.2 PERSONAL PROTECTIVE EQUIPMENT. Personal protective equipment shall be selected in accordance with AFOSH 91-31, AFOSH 48-1, other applicable AFOSH Standards, and guidance provided by Ground Safety & Bioenvironmental Engineering Flight.

2-6.2.1 Respirators. The local BES and the Entry Authority shall provide guidance on respiratory protection. In the absence of such guidance a Type C, full-face supplied air respirator shall be worn for all fuel cell/tank entries. All respirators shall be selected and maintained in accordance with AFOSH 48-1. Contact lenses shall not be worn with any respirator. Entry Authority/Supervisor will ensure air pressure supplied to respirator meets manufacturer's recommended pressures for specific respirators.

2-6.2.2 Goggles. Personnel performing work which generates dust or could cause fluids to enter the eyes shall wear splash, gas and/or particulate goggles if a full face respirator is not required. Contact lenses shall not be worn with any goggles or face shield.

2-6.2.3 Hearing Protection. The local BES shall determine hearing protection requirements based on a survey of operations performed.

### 2-6.3 MONITORING EQUIPMENT.

2-6.3.1 Portable Combustible Gas Meter. This meter may be combined with the oxygen meter. The combustible gas meter shall be capable of measuring common aviation fuel vapors when the

oxygen concentration is above 16 percent. A Bacharach 514 or equivalent meter shall be used to determine if the atmosphere in the tank is less than or equal to 5% LEL. The Bacharach 502 is not considered accurate in the 0 to 5% LEL range.

2-6.3.2 Oxygen Meter. This meter may be combined with the combustible gas meter. The oxygen meter should be capable of measuring oxygen concentrations in the 4 percent to 25 percent range.

2-6.3.3 Many meters have both oxygen and LEL measurement capability. These meters must meet the same general detection capability as the stand-alone equipment. These instruments require sufficient oxygen to be present to detect the LEL of fuel vapors.

2-6.3.4 Toxicity Indicators. In general, instrumentation designed to detect toxic chemicals is not required for day-to-day fuel systems maintenance. The local BES should conduct periodic sampling to detect and measure toxic substances.

## 2-6.4 EMERGENCY RESCUE AND RETRIEVAL EQUIPMENT.

2-6.4.1 Respirator. As a minimum a full-face, supplied air, respirator and all associated interconnects shall be maintained at the work site to use in emergencies. The fuel element chief and BES should select emergency escape respirators using the guidance in AFOSH 48-1.

2-6.4.2 Lifting and Retrieval Devices. These devices are used to assist in removing incapacitated personnel from tanks. These devices can damage the aircraft or further injure personnel if improperly designed or used. Approval for use of this type of equipment shall require coordination from the Aircraft System Program Manager (SPM)/Engineering, Fire Department, Ground Safety Office, Fuel Element Shop Chief, and BES.

2-6.4.3 Other equipment, if required, shall be approved by the System Program Director, Fire Department, Ground Safety office, fuel element shop chief, and BES as necessary.

## 2-7 SAFETY PRACTICES.

### 2-7.1 SUPPORT EQUIPMENT.

2-7.1.1 General. All rolling support equipment used in fuel systems repair areas/facilities shall be equipped with anti-static, non-metal, (rubber or composition) wheels. Equipment shall be inspected prior to being brought into the fuel systems repair area/facility. Fire extinguishers, sealant guns, mixers, communications equipment, aircraft jacks, and other similar equipment are not considered support equipment. Support equipment shall be inventoried or controlled to ensure

none is left on or in the aircraft during fueling, defueling or flight.

2-7.2 POWERED SUPPORT EQUIPMENT. Powered support equipment shall be positioned outside the 50 foot marked area. Equipment should be positioned upwind if possible to guard against possible ignition sources. All support equipment shall have cables and hydraulic lines in excess of 50 feet. Exceptions are the MA-1 blower, HDU-13/M heater, explosion proof fans/blowers, Air Purifier Cart, or any other explosion proof/intrinsically safe equipment which are allowed within the marked area. Equipment within the marked area shall be bonded to the aircraft. Equipment outside the marked area does not require grounding or bonding. Ambient air breathing equipment shall be positioned away from vehicle/equipment exhaust, ventilating/purging exhaust ducts or other similar operations to ensure air intakes are located in an uncontaminated area.

2-7.3 NON-POWERED SUPPORT EQUIPMENT. Work Stands. Personnel are subject to falling when working above floor level. Workstands shall be provided, used and maintained in accordance with applicable directives. Workstands shall have nonslip step surfaces. Worn step surfaces shall be repaired or replaced. Workstands shall have static discharge plates and bonding wires as required by paragraph 2-9.5.

### 2-7.4 TOOLS AND TOOL BOXES

2-7.4.1 Rubber wheeled, maxi-type tool boxes are authorized inside fuel systems repair facilities and areas without being grounded or bonded. All hand carried tool boxes brought into the fuel systems repair facility/area shall be placed on a non-metal, antistatic composition or rubber mat. At no time shall the box be placed on another surface or carried onto the aircraft or workstands. Tools required to perform maintenance shall be hand carried to the aircraft in non-metallic containers, such as fiber-board boxes or canvas bags. Tool boxes locked and secured in storage racks need not be removed from the fuel systems repair facility provided they remain locked in the storage rack.

2-7.5 FUEL COLLECTION CONTAINERS. Fuel shall only be collected in approved safety containers, bowsers, or rubber pails. All containers should be marked to denote grade of fuel contained. Bowsers and metallic safety containers shall be bonded to the aircraft during fuel transfer. Locally manufactured containers shall meet the requirements of TO 00-25-172. Drip pans are not approved fuel collection containers. Fuels without antistatic additives shall not be allowed to

free-fall into any container unless absolutely necessary (free-fall shall be kept to the minimum necessary). All pails and drip pans shall be emptied daily or more often as necessary.

## 2-7.6 ELECTRICAL EQUIPMENT

**2-7.6.1 Aircraft Radar.** Separation distances between fuel systems repair areas/facilities and aircraft radar should be provided in the systems technical orders. If the system technical order is not available or does not contain separation distances, then 300 feet (100 feet when using a dummy load) is the required minimum distance. Refer to TO 31Z-10-4 for additional information.

**2-7.6.2 Radios.** Mobile radios may be used in fuel systems repair areas/facilities for communication between job control and the fuel system work center or for emergency communication. Restrictions of TO 31Z-10-4 shall apply.

**2-7.6.3 Non-intrinsically safe radios** shall be kept at least 50 feet away. The distance requirements do not apply to adjacent offices that are enclosed.

**2-7.6.4 Intercoms, Radios, and Telephones.** Intrinsically safe radios/intercoms or telephones approved for NFPA 70 (National Electric Code) Class I, hazardous areas may be used. Intercoms, radios, and telephones are permitted in fuel systems repair areas/facilities to maintain communications between members of the entry team or other personnel. These items shall be maintained, inspected, and repaired in accordance with manufacturer's instructions.

**2-7.6.5 Flashlights.** Flashlights used in fuel systems repair areas/facilities shall be intrinsically safe or approved for NFPA 70 (National Electric Code) Class I, hazardous areas. Flashlights shall be checked for serviceability prior to use. As a minimum the flashlight shall have an unbroken lens, no missing seals or other visible defects.

**2-7.6.6 Lights.** All lights other than the Explosion Proof SCEON light (GSLX4000) and flashlights used for, or in, fuel systems repair areas/facilities shall be approved for NFPA 70 (National Electric Code) Class I, hazardous areas (explosion-proof type). To prevent thermal damage to cells and sealants a focusing lens or other light diffusing attachments shall be attached to the optical cable.

**2-7.6.7 Other Electrical Equipment.** All other electrical equipment used in fuel systems repair areas/facilities shall be either intrinsically safe or approved for NFPA 70 (National Electric Code) Class I, hazardous areas. In the event non-intrinsically safe or non-NFPA 70, Class I, approved

NDI equipment must be used, the tank shall be purged to 1.5% LEL or less and continuously air purged and monitored.

## 2-7.7 COMMUNICATIONS AND VISUAL AIDS

**2-7.7.1 Communication.** Voice or visual signal communications are essential to maintaining a safe working environment. Communication shall be maintained between all personnel present. The use of an approved radio, intercom, or telephone is recommended. Personnel shall be briefed on visual signals prior to each entry.

### 2-7.7.2 Streamers and Forms.

- a. All support equipment, plugs, caps, and cover plates connected to the aircraft shall have a red "REMOVE BEFORE FLIGHT" streamer. The red streamer will be attached at the point where the equipment is connected to the aircraft. AF Form 1492 shall not be used in lieu of red streamers.
- b. All vent plugs, vent caps, vent cover plates, and equipment that will affect the venting, fueling, defueling, or transferring of fuel on an aircraft shall have a yellow "REMOVE BEFORE FUELING/DEFUELING" streamer. If yellow streamers are not available AF Form 1492 (WARNING TAG) shall be used for each vent plug installed on the aircraft. The AF Form shall be attached to the single point refueling receptacle along with an AFTO Form 781A entry of location of plug. Yellow streamers can be locally manufactured and should be two to three feet long.

**2-7.7.3 Signs.** All fuel systems repair areas/facilities shall be clearly marked with warning signs "DANGER, OPEN FUEL TANKS, UNAUTHORIZED PERSONNEL KEEP OUT."

**2-7.7.4 Rope, Chain or Cable.** All fuel systems repair areas/facilities shall be marked off 50 feet from all points on the aircraft with rope, chain, or cable. The roping of facilities applies to those areas of the structure that are normally open and is intended to control foot traffic in to the facility. During combination air or exhaust purge an additional 50 feet radius downwind from the end of exhaust duct shall also be marked off.

**2-7.8 MUNITIONS, EXPLOSIVE, AND PYROTECHNIC DEVICES.** These devices by their nature are an additional source of fuel for a fire and may complicate rescue and fire fighting operations. The aircraft will be non-explosives loaded

in accordance with TO 11A-1-33. Generally this means egress, survival kits, destructors, fire extinguisher cartridges, and engine starter cartridges

may remain on the aircraft. These devices will be made safe in accordance with system manuals and



TO 11A-1-33 as applicable. All munitions including 30mm and smaller including TP ammo will be downloaded when any of the following conditions are present:

- a. The aircraft is in a hangar for fuel system maintenance.
- b. An entry permit is required to perform the maintenance task.
- c. Hot work is to be accomplished.
- d. The location of the outside repair area limits or hinders Fire Department response.

When working in approved fuel system maintenance areas munitions do not have to be downloaded if the maintenance task requires removal/replacement, inspection, and test of externally mounted fuel system components.

#### 2-7.9 AIRCRAFT OPERATIONS.

2-7.9.1 Aircraft shall not be allowed to operate under their own power within 100 feet of fuel systems repair areas or exposed portions of aircraft in facilities. Refer to paragraph 2-7.6, for information concerning operation of aircraft radar and communications equipment in the vicinity of fuel systems repair areas and facilities.

2-7.9.2 Minor encroachment of the 100 foot limit is permissible when the aircraft is fully enclosed in a hangar. However, engine operation in adjacent hangars or from aircraft on nearby taxi-ways may create noise or other hazards. These operations shall be curtailed when they impact the ability to safely conduct fuel system maintenance. Generally this will require coordination between the LG and OG staff.

2-7.10 EXTERNALLY MOUNTED FUEL SYSTEM COMPONENTS. Fuel system repairs which do not require fuel tank entry, depuddling, or purging operations may be accomplished in any facility, parking ramp, or open area approved for other types of aircraft maintenance. Aircraft power shall not be applied. Nonessential equipment will be removed or unplugged. Circuit breakers, power receptacles, and SPR connections shall be tagged to indicate maintenance is being performed. Electrical equipment will be approved for use in Class I hazardous areas. No other maintenance will be conducted on the aircraft during these repairs. Openings from the removed components shall be covered with locally manufactured caps or plugs to prevent fuel vapors from escaping through the opening. Barrier material, aluminum foil, plastic bags, etc., will not be used to cover the openings. The Fuel Element Chief will release the aircraft for other maintenance

once the repairs are complete or caps/plugs are in place.

#### 2-8 CONFINED SPACE ENTRY (FUEL CELL/TANK ENTRY).

##### 2-8.1 GENERAL.

2-8.1.1 Confined space entry can be for various reasons (e.g., inspection, repair, rescue). Non-emergency entry (i.e., maintenance, inspection, and etc.) into IDLH atmospheres will be conducted in accordance with AFOSH 91-25. Certain sequences of events may require entry into a confined space with hazards present beyond the scope covered in this manual. These entries will be coordinated with the local Safety and BES office. Instructions contained within this section and other sections of this TO will develop the requirements for "Permit Required Confined Spaces" in accordance with Air Force and OSHA health and safety directives. These procedures are for routine recurring entry in a non-IDLH atmosphere. Entry for rescue shall be conducted in accordance with the procedures set forth in the local rescue plan.

2-8.1.2 The requirements for the aircraft integral tanks and fuel cell confined space permit system are derived from Air Force and OSHA safety and health requirements.

##### 2-8.2 RESPONSIBILITIES.

2-8.2.1 The LG/CC or equivalent is responsible for the safe execution of all entries into and work performed in aircraft fuel tanks and cells, and for issuing over his/her signature the letter designating the Entry Authority and authorizing the issue of Field Permits (Entry Permit Authorization Letter).

2-8.2.2 Additionally, except as noted in paragraph 2-8.4.5, Fuel Element Chiefs will serve as the Entry Authority for all tank entries and are responsible directly to the LG/CC or civilian equivalent for ensuring all confined space entry requirements contained in this TO are met. See paragraph 2-8.4 for specific requirements. For organizations not having designated Fuel Element Chief, the supervisor most qualified and experienced in aircraft fuel system repair will be designated the Entry Authority.

2-8.2.3 Attendants have overall responsibility for monitoring the entry area inside and outside the aircraft fuel cell/tank, including termination of the entry if unsafe conditions develop. Specific duties of the attendant are listed in paragraph 2-8.4.4.f.2.

2-8.2.4 Entrants are responsible for complying with the conditions of the field permit, this TO and the directions of the attendant at all times, including vacating the tank/cell when so directed.

2-8.2.5 BES, Safety, and Fire Prevention officials are responsible for evaluating and coordinating on the Entry Permit Authorization Letter, in addition to those duties outlined by other Air Force directives.

2-8.2.6 Specific training requirements for entrants, attendants and equipment monitors/runners are contained in paragraphs 2-8.3 and 2-8.4.4. Training will be provided by qualified individuals on the installation using lesson plans or training outlines approved by the Entry Authority, the responsible Safety office, BES, and the Fire Department.

2-8.2.7 Vigilance is required on the part of all personnel who work in fuel cells/tanks (confined spaces).

2-8.2.8 Personnel Requirements. When entering a cell/tank a minimum of three people will be used, except at AFMC Air Logistics Centers. For Air Logistics Centers, manning requirements can be reduced in accordance with paragraph 2-8.2.8.f. One 2A6X4 person (or civilian equivalent) shall enter the tank, one 2A6X4 person (or civilian equivalent) shall remain outside the tank as an attendant to perform duties listed in paragraph 2-8.4.4.f.2, and a third person to serve as a runner/equipment monitor and for emergency response purposes.

- a. The Entry Authority shall designate a fuel tank entry chief for each tank entry. The fuel tank entry chief will have supervisory control over all other team members. Qualified attendants may serve as the tank entry chief
- b. The LG/CC, or civilian counterpart may substitute a non-2A6X4 person as an attendant when circumstances require, such as work stoppage due to fuel system personnel manning shortages or surges in workload to sustain readiness. The acceptance of reasonable risk should be weighed by the person exercising this authority to assure that safety is not compromised. Any non-2A6X4 individual selected as an attendant shall have either completed a fuel system repair school or have received training from the Fuel Element Shop Chief or designated alternate. The local training shall cover tank familiarization, safety equipment, grounding, bonding, purging procedures, depuddling, operations, using respirators, recognizing symptoms of toxicity from fuel and solvent vapors, and rescue/emergency procedures as well as the general duties of an attendant listed in

paragraph 2-8.2.3. Training or recertification shall be conducted annually.

- c. When authorized by the Entry Authority or Designated Alternate, an attendant may monitor more than one tank entry, as long as he can effectively perform the duties of an attendant as listed in paragraph 2-8.4.4.f.2.
- d. When authorized by the Entry Authority or Designated alternate the third person (runner/equipment monitor) may be omitted if not required for removal of an entrant incapable of self rescue.
- e. When authorized by the Entry Authority or Designated alternate, the third person may perform the runner/equipment monitor duties for more than one cell/tank entry as long as the runner/equipment monitor remains in the immediate area of the cell/tanks, e.g, within shouting distance, and is otherwise capable of executing any responsibilities assigned as the runner/equipment monitor by the Emergency Response Plan.
- f. At AFMC Air Logistics Centers, the third person (runner/equipment monitor) may be omitted when it is determined that the person is not required by the Emergency Response Plan (reference paragraph 2-8.3), to monitor support equipment or fire extinguishers, and provided that an alternate means of communication is available between the attendant and maintenance control/operations or other designated alert station.

## 2-8.3 EMERGENCY RESPONSE PLAN AND PROCEDURES.

2-8.3.1 Each repair activity in coordination with installation medical services, Fire Department, Safety, and BES officials, will develop a written Emergency Response Plan. The plan will establish a rescue team consisting of personnel to remove individuals incapable of self-rescue from tanks from which such a removal is possible, and base or local emergency response agencies to provide immediate medical care, and removal if not otherwise possible. The plan will account for all foreseeable rescue situations. Minimum requirements are listed below:

2-8.3.2 For those tanks/cells that entry for removal is possible, the plan will identify either the authorized attendant or the runner/equipment monitor for initial removal attempts employing the following procedures:

- a. Prior to any tank entry for removal of an incapacitated entrant, the attendant will alert the runner, ensure that the tank is being properly ventilated, determine, through contact with the entrant if possible, the nature of the emergency, assess the conditions of the tank, and make any rescue attempts possible from outside the tank. The runner will sound the alarm by the quickest means available and initiate contact with emergency response agencies. The plan will describe how this notification is to be accomplished.
- b. If the plan designates the authorized attendant for removal, the attendant may don respiratory protection, but will not enter the tank until the runner assumes the duty of the attendant. In this event the runner must be trained and capable to perform the duties of an attendant as listed in paragraph 2-8.2.3, and 2-8.4.4.f.1.
- c. If the runner is designated for removal, the attendant will not leave the tank/cell once the runner has entered.
- d. Attendants or runners designated for initial removal will be trained in CPR and self aid/buddy care (or equivalent).

2-8.3.3 Emergency Response Plans will list equipment and facility requirements necessary to safely remove an incapacitated entrant.

2-8.3.4 Emergency Response Plans will define the roles and activities of all responding emergency agencies, including rescue from a tank from which removal by the attendant or runner has failed or is not possible.

2-8.3.5 Rescue capability must exist for all shifts during which tank entry is accomplished. The size

of the rescue team must be sufficient to ensure that no unattended rescue activity occurs.

2-8.3.6 Although the most likely rescue will be from a non-IDLH environment, the plan will account for rescue from an IDLH environment as defined in paragraph 2-8.4.1.a.1.

2-8.3.7 The plan will be exercised at least once every year, during which the rescue team will practice making removals from actual or simulated tanks. Dummies or mannequins can be used for the exercise.

2-8.3.8 Emergency Response Plans and Procedures at AFMC Air Logistics Centers (excluding AMARC). Emergency Response Plans at AFMC Air Logistics Centers may deviate from the specific requirements contained in paragraph 2-8.3.2. The Emergency Response Plan will, however, account for immediate removal of entrants not capable of self-rescue (when such removal is possible) and the training, qualifications and responsibilities for individuals making such removals. Paragraphs 2-8.3.3, through 2-8.3.7 do apply to AFMC Air Logistics Centers.

## 2-8.4 CONFINED SPACE ENTRY REQUIREMENTS

### 2-8.4.1 GENERAL.

- a. Aircraft integral tanks and fuel cells will be considered permit required confined spaces. A permit shall be obtained prior to making a tank entry. (Exception #1: If the maintenance or inspection procedures require only hand/arm entry into a confined space and there is no possibility of injury from electrical or mechanical



hazards, no permit is required. Exception #2: An enclosed area which is configured such that personnel cannot become entrapped will not require a permit. An example of this type of entry is a wet wing on a fighter aircraft.) Proper personal protective equipment and all safety precautions for open tank maintenance shall be used for all maintenance. See glossary for definition of entry, enclosed areas, and confined spaces.

- (1) Tanks containing atmospheres considered to be immediately dangerous to life and health (IDLH) will not be entered using the confined space entry procedures of this section. For the purposes of this TO, IDLH is considered to be LEL of greater than 20%, oxygen content of 19.5% or less or greater than 23.5%, or a toxicity level of any chemical agents used in the tank at or above IDLH levels specified by BES.
- (2) Tank entries for the purposes of rescue will be performed by trained, predesignated teams as specified by paragraph 2-8.3.
- (3) All other tank entries will be controlled by a permit system issued in accordance with paragraphs 2-8.4.2, and 2-8.4.4. Unattended entry shall never be authorized.
- (4) All participants in fuel tank entries will be trained as required by paragraph 2-8.4.4.e, and 2-2.3.

**2-8.4.2 Entry Permit Authorization Letter.** The Entry Permit Authorization Letter certifies the Fuel Systems Repair Supervisor to act as the Entry Authority for aircraft fuel cell/tank entries. The Entry Permit Authorization Letter does not authorize entrance into any permit required space. The authorization letter will be developed by the organization performing fuel tank/cell entries and approved by LG/CC, Installation BES, Safety, and Fire Prevention Officials. The AF Form 1024, Confined Space Entry Permit, which is approved for local reproduction (LRA), with addendums and modified as necessary to meet the requirements of this TO or a locally developed letter may be used. Figure 2-2 is a sample Entry Permit Authorization Letter.

- a. The Entry Permit Authorization Letter will be issued for a maximum of one year.

- b. The Entry Permit Authorization Letter will certify, by name and position, the Entry Authority and Designated Alternates.
- c. The Entry Permit Authorization Letter will describe the conditions under which the Entry Authority or Designated Alternates may issue Field Permits including:
  - (1) Type aircraft to which the Entry Permit Authorization Letter and Field Permits will apply
  - (2) General descriptions of the routine and recurring type work to be performed during permitted entries and the work centers which will be performing the work
  - (3) Authorized atmospheric conditions of the tank (e.g, tank properly purged, LEL, Oxygen, toxicity at prescribed levels)
  - (4) Type chemicals, sealants, adhesives, etc authorized to be used in the tank. Generally, any required by TO 1-1-3 procedures should be authorized, along with any other routinely used material that has been fully evaluated and approved by the local safety, fire, and BES.
  - (5) Procedures, practices and personnel requirements for periods of deployment to non-Air Force installations or during readiness exercises and operations at remote locations.
  - (6) Additional location specific conditions deemed necessary by local BES, Safety, or Fire Officials.
- d. The Entry Permit Authorization Letter will specifically state that any entry not consistent with the conditions of the Entry Permit Authorization Letter will not be authorized by the Entry Authority or any Designated Alternates.
- e. As part of the annual authorization process, the LG/CC, BES Ground Safety, and Fire Prevention officials must review, validate and approve the Entry Permit Authorization Letter. This approval will be based on reviews and assessments of:
  - (1) Maintenance fuel cell/tank familiarization training and related confined space training programs developed as required by paragraph 2-2.3.

- (2) The selection process for Designated Alternate Entry Authorities.
- (3) Field Permit issuing procedures.
- (4) The operation and condition of sampling equipment (i.e., combustible gas indicators and oxygen meters, and other direct reading instruments.).
- (5) The condition and use of personal protective equipment.
- (6) The organizations Fuel Cell/Tank Emergency Response Plan.

2-8.4.3 Designated Alternate Entry Authorities. Designated Alternates are selected by the Entry Authority and Certified on the Entry Permit Authorization Letter. There should be sufficient Designated Alternates to ensure coverage of all operations and shifts. Designated Alternates will as a minimum be:

- a. Fully qualified on aircraft fuel system maintenance.
- b. Knowledgeable of the hazards of a confined space, the testing and monitoring requirements of the specific confined spaces, the rescue procedures, and the confined space entry requirements contained in this TO.

2-8.4.4 Field Permit Issue. The Entry Authority/ Designated Alternate will:

- a. Only issue an entry permit after all controls and testing are accomplished.
- b. Never permit entry into a tank or cell with an IDLH atmosphere.
- c. Ensure all entries and work performed adhere to the safety practices and procedures contained in this TO.
- d. Establish and maintain a system for controlling entry into all aircraft fuel tanks and cells.

- (1) The Entry Authority or Designated Alternate will only issue a Field Permit for tank entries performed under conditions consistent with the Entry Permit Authorization Letter Field Permits may be issued for similar tasks performed under similar conditions in different tanks/cell on the same aircraft. The Field Permit will cover the duration of the task(s) to be performed unless conditions under which the Field Permit was issued change prior

to task completion. The Field Permit will never be issued for more than one year.

- (2) The Entry Authority or Designated Alternates will amend or reissue the Field Permit if conditions of the original Field Permit change prior to task completion and if the changed conditions are consistent with the Entry Permit Authorization Letter. Field Permit conditions are considered changed if:

- (A). the originally permitted task(s) change
- (B). the aircraft is moved
- (C). conditions not in adherence to this TO develop
- (D). chemicals other than originally permitted are introduced into the tank
- (E). previously non-permitted personnel require entry into the tank
- (F). or any condition outside the scope of the Entry Permit Authorization Letter develop. Any conditions or changes not consistent with the Entry Permit Authorization Letter require approval from LG/CC, BES, Ground Safety, and the Fire Department before entry.

- (3) The Field Permit will be a written document. The AF Form 1024, Confined Spaces Entry Permit, which is authorized for local reproduction (LRA), with addendums and modified as necessary to contain the requirements of this TO as well as additional guidance that may be dictated by local conditions or a locally developed form may be used. Figure 2-1 is a sample Field Permit.

- (4) The Field Permit will be available at the job site during tank entry. When the task is completed, the Field Permit will be returned to the Entry Authority and cancelled. The cancelled permit shall be retained for one year.

- e. Ensure all entrants are qualified for tank entry.

- (1) Entrants, as a minimum, must be medically qualified, respirator certified in accordance with AFI 48-1, have received hazard communication training in accordance with AFOSH Standard 161-21, and had fuel tank/cell familiarization training as required by paragraph 2-2.3 of this TO including: Confined space hazards related to fuel cells, personnel protective equipment requirements, and self rescue.
  - (2) Prospective entrants not meeting the above qualifications will not be permitted entry into a tank or fuel cell.
- f. Ensure attendants are trained and available for all entries.
- (1) The Entry Authority or Designated Alternate shall provide a fully qualified Fuel Systems Repair specialist to act as an attendant for all entries. Attendants will be knowledgeable of the following: the emergency response plan and procedures, proper use of communication equipment, procedures for summoning rescue team and positioning of emergency equipment, recognition of early behavioral signs of potential overexposure caused by chemicals used in the tank, and the duties of an attendant as listed in 2-8.4.4.f.2. Under certain exceptional circumstances, other than fuel cell repair specialists may be selected as attendants in accordance with paragraph 2-8.2.8.b.
  - (3) Attendants may monitor more than one tank entry if capable of performing the duties listed in paragraph 2-8.4.4.f.2.
  - (4) The use of electronic or video personnel monitors are encouraged and may reduce the number of attendants required to monitor tank entries.
  - (5) These devices when used properly, provide nearly continuous monitoring of personnel inside large airframe tanks. If used, sufficient attendants to control the area around the space and prevent unauthorized entry will still be required. Such devices must meet NFPA 70 requirements for use in Class I environments.
- g. The entry authority will ensure runners/equipment monitors are provided as required by paragraph 2-8.2. Runner/equipment monitors designated as part of the rescue team for removal of incapacitated entrants will be trained as required by paragraph 2-8.3. Runners whose duties may entail entering the tank for any reason will be trained and qualified to enter and listed on the permit.

**WARNING**

Improperly executed fuel tank/cell rescue attempts will result in severe injuries or deaths. Attendants must never enter a permitted confined space, including for rescue, unless allowed by the Emergency Response Plan (refer to paragraph 2-8.3). In the event of an emergency, the attendant must summon help, and make all attempts possible to rescue the entrant without entering the tank or cell.

- (2) The attendant will be stationed at the entrance and remain outside of the entered tank. Duties of the attendant include: monitoring of activities inside

2-8.4.5 Aircraft at Air Logistics Centers and AMARC. The provisions of paragraphs 2-8.4.1, through 2-8.4.2, will apply to depot maintenance from the time the aircraft is received through the time the aircraft has been properly fluid purged, depuddled and made safe as required by paragraph 2-11.1.2, and during all periods of maintenance performed after fuel has been reintroduced to the aircraft tanks. ALCs and AMARC will establish and document procedures to include a permit system for all other tank entries consistent with the safety and health requirements of AFOSH 127-25 (AFI 91-25) and 29 CFR 1910.146.

2-8.4.6 DEPLOYED AIRCRAFT.

- a. When deployed to another Air Force installation, all tank/cell entries will comply, to the maximum extent possible, with the requirements of the Entry Permit Authorization Letter at the deployed location.
- b. When deployed to Non-AF military installations, adhere to the requirements of Entry Permit Authorization Letter at the home base to the greatest extent possible.
- c. When deployed to a BARE base or remote location the unit will make provisions for at least two qualified fuel system repair specialists for each entry. The runner/equipment monitor will be selected from available on-site personnel and will be briefed on his/her duties including emergency response procedures. Adhere to the requirements of Entry Permit Authorization Letter at the home base to the greatest extent possible.
- d. Tank/cell entry will not be made until emergency medical response procedures appropriate to the location have been identified. The team will deploy with one combustible gas indicator, one oxygen indicator and sufficient air-line respirators to ensure safe entry.

2-8.4.7 TRANSIENT AIRCRAFT.

- a. When an aircraft is at an AF installation the fuel system repair specialist will coordinate all entries with local personnel. This

individual will serve as the entry chief. Adhere to the requirements of Entry Permit Authorization Letter at the host base to the greatest extent possible.

- (1) If additional entrants are required, the entry chief shall provide familiarization training to fuel systems repair specialist from the host base.
  - (2) The attendant and other personnel may be selected from the local fuel system repair shop. The attendant shall be briefed by the entry chief on the work to be performed, and provided an overview of the aircraft fuel system/tank.
- b. When an aircraft is at a non-AF installation, BARE Base, or remote location the unit will make provisions for at least two qualified fuel system repair specialists for each entry. The runner/equipment monitor will be selected from available on-site personnel and will be briefed on his/her duties including emergency response procedures. Adhere to the requirements of Entry Permit Authorization Letter at the home base to the greatest extent possible.
  - c. Tank/cell entry will not be made until emergency medical response procedures appropriate to the location have been identified. The team will deploy with one combustible gas indicator, one oxygen indicator and sufficient air-line respirators to ensure safe entry.

AIRCRAFT TAIL NUMBER	AIRCRAFT LOCATION (Spot, Ramp)
JOB/TASK:	DATE DURATION: <b>UNTIL TASK IS COMPLETE</b>
COMMUNICATION PROCEDURES: RADIO _____	
TELEPHONE _____ ALARM _____ RUNNER _____	
MONITORING EQUIPMENT _____ DATE OF CALIBRATION _____	
HAZARDS PRESENT: FUEL TYPE _____ INERTING GAS _____	
CHEMICALS KNOWN TO BE PRESENT _____	
<b>CHEMICALS TO BE USED: THOSE AUTHORIZED IN T.O. 1-1-3 AND OTHER APPLICABLE TECHNICAL DIRECTIVES</b>	
PURGE METHOD: AIR _____ FLUID (FLUID USED) _____	
OXYGEN LEVEL (MUST BE BETWEEN 19.5% AND 23.5%) _____ DATE _____ TIME _____	
%LEL _____ DATE _____ TIME _____	
TOXICITY (Date of last Bioenvironmental Engineering assessments) _____ DATE _____	

**MONITORING REQUIREMENTS:****OXYGEN LEVEL:**

AIR PURGE PRIOR TO FIRST ENTRY OF EVERY SHIFT AND EVERY FOUR HOURS  
THEREAFTER OR MORE OFTEN AS DEEMED NECESSARY

FLUID PURGE: PRIOR TO FIRST ENTRY OF EVERY SHIFT OR MORE OFTEN AS  
DEEMED NECESSARY

AIR PURGE: PRIOR TO FIRST ENTRY OF EVERY SHIFT AND EVERY FOUR HOURS  
THEREAFTER OR MORE OFTEN AS DEEMED NECESSARY

*Figure 2-1. Sample Entry Permit Authorization Letter (Sheet 1 of 2)*

LOCATION OF HAZARD SIGNS: **SIGNS PLACED IAW T.O. 1-1-3**

PRE-ENTRY CHECKLIST COMPLETED AND AVAILABLE? \_\_\_\_\_

ISOLATION PROCEDURES:

LOCKOUT/TAGOUT (ELECTRICAL) NOT REQUIRED \_\_\_\_\_ COMPLETED \_\_\_\_\_  
LOCKOUT/TAGOUT (MECHANICAL) NOT REQUIRED \_\_\_\_\_ COMPLETED \_\_\_\_\_

VENTILATION: CONTINUOUS MECHANICAL VENTILATION REQUIRED DURING ALL ENTRIES

EQUIPMENT USED \_\_\_\_\_

PERSONAL PROTECTIVE EQUIPMENT:

RESPIRATOR \_\_\_\_\_ COVERALLS \_\_\_\_\_ OTHER \_\_\_\_\_

REMARKS/ADDITIONAL INFORMATION:

ALL TYPED INFORMATION IS EXTRACTED FROM T.O. 1-1-3.

RESCUE TEAM: (MINIMUM OF TWO PEOPLE) IN CASE OF EMERGENCY  
CONTACT \_\_\_\_\_

(THE PERMIT SHOULD DESIGNATE WHO (EITHER THE ATTENDANT OR RUNNER) IS ASSIGNED RESPONSIBILITY TO PARTICIPATE ON THE EXTRACTION TEAM (IN ACCORDANCE WITH THE EMERGENCY RESPONSE PLAN.))

LOCATION OF RESCUE EQUIPMENT: **SPARE RESPIRATOR IS ON SITE**  
OTHER EQUIPMENT \_\_\_\_\_

NAME OF ATTENDANT \_\_\_\_\_

(ATTACH LIST IF NECESSARY)

AUTHORIZED ENTRANTS \_\_\_\_\_

(ATTACH LIST IF NECESSARY)

ENTRY CHIEF \_\_\_\_\_

ENTRY AUTHORITY \_\_\_\_\_ SIGNATURE/DATE \_\_\_\_\_

TITLE \_\_\_\_\_

Figure 2-1. Sample Entry Permit Authorization Letter (Sheet 2 of 2)

## Entry Permit Authorization Letter

ORGANIZATION \_\_\_\_\_ ISSUE DATE \_\_\_\_\_ EXPIRATION  
DATE \_\_\_\_\_

**SECTION 1. ENTRY AUTHORITY AND DESIGNATED ALTERNATES:** The below listed individuals are authorized to issue Field Permits for entry into (list specific types of aircraft) fuel tanks/cells to perform tasks listed in SECTIONS 2 and 3 below.

NAME	UNIT	JOB TITLE
Entry Authority	Designated Alternate	Designated Alternate

**SECTION 2. FUEL SYSTEM REPAIR TASKS AND EJECTED TANK CONDITIONS.** The tasks listed below will be performed by personnel from the Fuels System Repair Work Center. Personnel on entry teams are trained as required by TO 1-1-3 and all entries will be made in accordance with the requirements of TO 1-1-3.

a. General Tank Conditions: Tanks will be continuously air purged when entered. LEL will be maintained at 10% or less (20% for foam removal) and oxygen content will be between 19.5 and 23.5%.

b. Specific Tasks.

TASK NAME	GOVERNING	CHEMICALS	EXPECTED	PERSONAL
TYPE	T.O. OR	OR	AIRBORNE	PROTECTIVE
ACFT	DIRECTIVE	HAZARDOUS	LEVELS/DATE	EQUIPMENT/
		MATERIALS	OF BES	RESPIRATOR
			EVALUATION	

(Use this section to list the recurring inspection and maintenance tasks performed by Fuel Systems Repair personnel. Task names should be as brief, but as descriptive as possible. Listing the date of the last BES Evaluation is highly recommend because that information will be required on the Field Permit.)

**SECTION 3. NON-FUEL TANK/CELL REPAIR TASKS AND EXPECTED CONDITIONS.** Tank entry for the purposes of completing the below listed tasks will be performed by the Work Centers listed. Entry teams are trained as required by TO 1-1-3 and all entries will be made in accordance with the requirements of TO 1-1-3.

a. General Tank Conditions: Tanks will be continuously air purged when entered. LEL will be maintained at 10% or less (20% for foam removal) and oxygen content will be between 19.5 and 23.5%.

b. Specific Tank Conditions: (Insert a table, or listing similar to the one above in SECTION 2. Include the Work Centers performing the work.)

**SECTION 4. ATMOSPHERIC MONITORING EQUIPMENT.** (Use this section to list the specific pieces of equipment used to monitor atmospheric conditions combustible gas meter, Oxygen analyzer, etc, in a fuel tank/cell. List by name and model number. Calibration requirements should also be listed.)

Figure 2-2. Sample Entry Permit Authorization Letter (Sheet 1 of 2)

SECTION 5. DEPLOYMENT AND READINESS PROCEDURES. (The suggested language provided below will require extensive tailoring to meet the expected mission requirements of a specific organization. The intent of this section is to ensure that tank/cell entries made at other than the home base are done consistent with Air Force safety and health requirements. Tasks to be performed at deployed locations should be defined and pre-planned to the extent possible. The permit would then list such items as required personal protective equipment to be deployed, minimum manning, and emergency response procedures.)

When deployed to another Air Force installation, all tank/cell entries will comply with the requirements of the Entry Permit Authorization Letter at the deployed location. When deployed to Non-AF military installations, adhere to the requirements of this permit to the extent possible. When deployed to a bare base or remote location the unit will make provisions for at least two qualified fuel system repair specialists for each entry. The runner/equipment monitor will be selected from available on-site personnel and will be briefed on his/her duties including emergency response procedures. Tank/cell entry will not be made until emergency medical response procedures appropriate to the location have been identified. The team will deploy with one combustible gas indicator, one oxygen indicator and sufficient air-line respirators to ensure safe entry.

SECTION 6. EMERGENCY RESPONSE PLAN.

Where Maintained\_\_\_\_\_ Last Review/Update\_\_\_\_\_

SECTION 7. ADDITIONAL REQUIREMENTS (Use this section to list any additional requirements mandated by local conditions, if any).

SECTION 8. AMENDMENT PROCEDURES. Field Permits for tank/cell entries not consistent with this Master Permit will not be issued without prior approval from LG/CC, Safety, BES, and the Fire Department. After receiving approval, routine and recurring tasks may added to this Permit on attached sheets with reference to the appropriate Permit section.

SECTION 9. APPROVALS

Entry Authority (signature/date) Safety Office (signature/date)

BES (signature/date)

Fire Department (signature/date)

DCM, LG/CC, or civilian equivalent (signature/date)

NOTE (This figure is to provide a suggestion on the form and style of the Master Permit. The AF Form 1024, Confined Spaces Entry Permit, as well as local produced forms or letters, may be used. As a minimum, Entry Permit Authorization Letter must contain the elements listed in paragraph 2-8.4.2.

*Figure 2-2. Sample Entry Permit Authorization Letter (Sheet 2 of 2)*

## 2-9 AIRCRAFT AND FACILITIES PROTECTION.

### 2-9.1 FUEL SYSTEM REPAIR OPERATIONS.

2-9.1.1 JP-5 and JP-8 Serviced Aircraft. Fueling, defueling, draining, depuddling, fuel transfer, or purging operations of fueled aircraft, may be accomplished in an approved fuel systems maintenance facility or an approved open area.

2-9.1.2 JP-4 Serviced Aircraft. Fueling and defueling shall not be accomplished inside any facility. Draining, depuddling, fuel transfer, or purging operations, of fueled aircraft, may be accomplished in an approved fuel systems maintenance facility or an approved open area.

2-9.1.3 No other maintenance will be permitted during air or fluid purging.

### 2-9.2 FIRE PROTECTION.

2-9.2.1 Fuel Systems Repair Facilities. All fuel system repair facilities shall have fire protection requirements meeting the requirements of Section III.

2-9.2.2 Fire-Safe Determination - Oxygen Content and Combustible Vapor Lower Explosive Limit (LEL) Test Procedures. Oxygen content of the tank shall be checked prior to checking the LEL. Equipment shall be calibrated and operated in accordance with the manufacturer's instructions or AF technical orders. The tank atmosphere shall be checked prior to the first entry of every shift and; every four hours for air purged aircraft (every eight hours for fluid purged aircraft) or as often as deemed necessary to determine if the aircraft is entry/fire-safe. Readings should be taken at various points in the tank to ensure the atmosphere is acceptable.

2-9.2.3 Fuel Systems Repair Areas. Fuel systems repair areas shall be equipped with at least two 150 pound Halon 1211 fire extinguishers. Additional extinguishers shall be provided when required by the Base Fire Marshal. Each extinguisher shall be inspected for serviceability. Fire extinguishers should be positioned such that they do not create a hazard in the area but are available for immediate use.

2-9.2.4 Area monitoring (checking of flammable vapors in trench and floor areas) is required for fuel systems repair facilities when JP-4 or AVGAS serviced aircraft are present. Aircraft serviced with JP-8, JP-5 or fluid purged do not require area monitoring.

2-9.2.5 Fuel vapors shall be extracted from the facility. Floor or trench exhaust shall be operated during defuel, fuel, air purge, fuel transfer, and

draining operations unless ducts are used to direct the vapors outside.

2-9.2.6 Hot Work. The Fire Department shall approve all hot work (e.g. grinding, welding, and brazing) on aircraft and fuel system repair facilities. (refer to instructions on AF Form 592)

2-9.3 AIRCRAFT MOORING AND GROUND HANDLING. Aircraft mooring and ground handling shall be in accordance with the applicable weapon systems technical order.

### 2-9.4 AIRCRAFT ELECTRICAL SYSTEMS.

2-9.4.1 Batteries. All batteries shall be disconnected, in accordance with the weapon system manual, and cables (or batteries) tagged with either an AF Form 1492 or 979. External power receptacles shall be tagged with an AF Form 1492 or 979.

2-9.4.2 Fuel Quantity Wiring Harness Repairs. When harness repairs are required, all repairs will be made in accordance with TO 1-1-14 and performed outside the tank or cell. Ensure open tanks/cells are purged to at least a 1.5 percent LEL or less. All open tanks/cells will have LEL monitored continuously.

2-9.4.3 Fuel Probe Testing. The test may be accomplished while the probe is electrically connected to the aircraft using a GTF-6, GTF-20, or equal provided there is no fuel or fuel vapor in the vicinity of the equipment. The equipment shall be located at least five feet from any open: fuel tank access cover, over-the-wing refill port, probe cover, vent or etc.

2-9.4.4 Electrical Conduit Repairs. Fuel leaks in electrical conduit which enters/exits fuel tanks shall not be repaired by applying sealants externally or by using other temporary repairs to the conduit. When fuel is discovered in an electrical conduit the affected component shall be repaired or replaced.

### 2-9.5 GROUNDING/BONDING

2-9.5.1 Grounding/Bonding Hardware. Grounding/bonding wires shall be constructed to fasten directly to the aircraft's static grounding system. All grounding/bonding hardware shall be inspected using the criteria outlined in TO 00-25-172.

#### 2-9.5.2 Aircraft.

- a. Temporary Repairs (Section IV). The aircraft need not be grounded. Personnel shall touch an aircraft ground receptacle (to neutralize static charge and prevent static discharge from occurring near fuel

vapors) prior to performing inspections and repairs.

- b. Other Maintenance and Inspections. The aircraft shall be grounded when in fuel system repair areas/facilities and remain grounded for the duration of the maintenance or inspection.

2-9.5.3 Support Equipment. Powered and non-powered support equipment shall be bonded to the aircraft by attaching a cable from the equipment to aircraft receptacle.

2-9.5.4 Workstands. All metallic workstands shall be equipped with a static discharge plate made of copper, zinc or zinc coated material. The plate shall be welded to the handrail at the entrance to the stand. The plate shall be marked "PERSONNEL STATIC DISCHARGE PLATE."

2-9.5.5 Drop, External, Ferry, Benson, Weapons Bay Tanks. Ground metallic tanks during periods of in-tank inspection and maintenance. During inspections and maintenance bond blower ducts, maintenance stands, and support equipment to metallic tanks. The tanks do not need to be grounded when stored, parked, or during other periods when in-tank work is not being accomplished. Prior to draining or pouring fuel from a metallic container/tank into a metallic container/tank, momentarily touch the container to the tank to neutralize the charge.

2-9.5.6 Non-metallic Tanks, Workstands, and Other Objects. Non-metallic objects (e.g., non-metallic tanks, fiberglass ladders, and rubber buckets) do not need to be grounded or bonded.

2-9.6 HOUSEKEEPING. Fuel systems repair areas/facilities shall be maintained to a reasonable level cleanliness and order. Oil, grease and fuel contaminated rags shall be placed in proper containers. Spills and leaks shall be cleaned/contained to prevent creating a fire or trip hazard. Small spills (Class I, not over two feet in any direction) shall be immediately cleaned. If a large amount of fuel is spilled (Class II or III) during draining or transfer, the operation shall be stopped, power turned off, and the fire department notified. Work shall not resume until the area is determined safe by the fire department. Equipment shall be stowed or positioned so as not to block passage, or create a hazard. During fuel system maintenance, the facility shall not be used to store materials, equipment, vehicles, etc., which could create a fire hazard, obstruct aircraft egress, or hinder fire fighting and rescue operations.

## 2-9.7 FUEL FOAM STORAGE.

2-9.7.1 Indoor Storage. Foam stored indoors shall be placed in clean electro-static free plastic bags or canvas bags or placed on a clean electro-static free plastic or canvas ground cloth and covered with clean electro-static free plastic or canvas if the foam is to be reused. The bags shall be either placed in a segregated storage area or retained near the aircraft. Segregated storage areas shall be approved by the base fire marshal and ground safety office. Foam shall not be stored in direct sunlight, exposed to high temperatures or high humidity.

2-9.7.2 Outdoor Storage. Short term outdoor storage of foam is authorized for aircraft which are in fuel systems repair areas not co-located with an approved fuel system repair facility or segregated foam storage area. Foam shall be protected from exposure to particulate contamination, direct sunlight and water. Foam should either be placed in clean electro-static free plastic, or canvas bags, or placed on a clean electro-static free plastic or canvas ground cloth and covered with clean electro-static free plastic or canvas. Foam should be stored in shaded areas around or under the aircraft.

2-9.7.3 Foam which is not to be reused shall be stored and disposed of in accordance with applicable environmental regulations.

## 2-9.8 SEVERE WEATHER

2-9.8.1 Field Maintenance. When thunderstorms/lightning are within a five nautical mile radius of the repair site operations shall be suspended. The Logistics Group Commander in coordination with the Base Weather Station will develop and implement warning procedures, so that timely precautionary measures may be taken when conditions warrant. When the Base Weather Station provides notification of lightning/thunderstorms (normally 30 minutes prior to the storms being within five nautical miles), the Fuel Element Chief shall initiate action to ensure operations are suspended by the time the severe weather is within five nautical miles. Additionally, the Logistics Group Commander, in coordination with the Base Weather Station will develop (if not already established) or incorporate procedures for high wind conditions into existing OI procedures addressing fuel system maintenance during periods when high winds could be considered dangerous (usually 30 kts or higher). The local Fire Chief, Ground Safety and Logistics Group, Commander should all coordinate on the OI. The OI will address outside areas as well as inside facilities (as applicable). Hazards normally associated

with high winds (e.g., firefighting problems, potential for maintenance personnel to be blown off aircraft surfaces, blown debris, and etc.) should be addressed in the OI. When operations are suspended, access panels, filler caps, and any other aircraft openings removed for maintenance, shall be temporarily closed. When temporarily closing a panel it may not be necessary to use a full complement of fasteners. If less than the full complement of fasteners is used to temporarily secure a panel the fasteners shall be spaced to ensure the panel is secure. If temporary panels are used, panels will be manufactured from non-conductive materials.

2-9.8.2 Depot Maintenance at Air Logistics Centers (ALCs). When thunderstorms/lightning are within a five nautical mile radius of the repair site operations shall be suspended on aircraft that are not fully enclosed within a hangar and meeting the requirements of paragraph 2-11. The Production Division Chief in coordination with the Base Weather Station will develop and implement warning procedures so timely precautionary measures may be taken when conditions warrant. When the Base Weather Station provides notification of lightning/thunderstorms (normally 30 minutes prior to the storms being within five nautical miles) the Production Division Supervisory Personnel shall initiate action to ensure operations are suspended by the time the severe weather is within five nautical miles. Additionally, the Production Division Chief in coordination with the Base Weather Station will develop (if not already established) or incorporate procedures for high wind conditions into existing OI procedures addressing fuel system maintenance during periods when high winds could be considered dangerous (usually 30 kts or higher). The local Fire Chief, Ground Safety and Production Division Chief, should all coordinate on the OI. The OI will address outside areas as well as inside facilities (as applicable). Hazards normally associated with high winds (e.g., firefighting problems, potential for maintenance personnel to be blown off aircraft surfaces, blown debris, and etc.) should be addressed in the OI. When operations are suspended, access panels, filler caps and any other openings removed for maintenance shall be temporarily closed on all aircraft which do not meet the requirements of paragraph 2-11. Local management will determine to what extent it is necessary to close access covers, filler caps and other openings for aircraft which meet the requirements of paragraph 2-11. When temporarily closing a panel it may not be necessary to use a full complement of fasteners. If less than the full complement of fasteners is used to temporarily secure a panel the fasteners shall be spaced to ensure the panel is

secure. If temporary panels are used, panels will be manufactured from non-conductive material.

2-10 MAJOR DISASSEMBLY (CONTRACTOR AND FIELD). Aircraft at activities for major disassembly shall have all fuel removed from the fuel system (pumps, tanks, lines, and other components) prior to moving the aircraft into a non-approved facility. The aircraft shall be checked to ensure a fire-safe condition is maintained.

## 2-11 DEPOT MAINTENANCE

### 2-11.1 Depot Maintenance at Air Logistics Centers (ALCs):

2-11.1.1 Hangared aircraft at an ALC, as a minimum, will meet the firesafe definitions contained in Section V. Ramp areas used for fuel system repair may be designated in accordance with paragraph 2-7.7.4 or in accordance with NFPA 410. If ramp areas are designated in accordance with NFPA 410 the ALC Safety office, Fire Department, and Production Division Chief will develop and implement controls necessary to ensure foot and vehicular traffic are directed around fuel system maintenance areas.

#### WARNING

- When aircraft fuel tanks/cells are blow purged alone, potentially flammable environments can be rapidly regenerated once the air source is removed. Blow purging to 5% of LEL will not be considered as compliance with paragraph 2-11.1.2. Once fuel or any other flammable material capable of generating 5% LEL or greater is reintroduced into the tank/cell, the provisions of paragraphs 2-11.1.2.a, through 2-11.1.2.e, will not apply.
- The provisions of paragraphs 2-11.1.2.a through 2-11.1.2.e shall apply only if the combustible gas indicator is capable of accurately measuring the %LEL in the 0 to 5% range. A Bacharach 514 or equivalent meter shall be used to determine if the atmosphere in the tank is less than or equal to 5% LEL. The Bacharach 502 is not considered accurate in the 0 to 5% LEL range.

2-11.1.2 Once the entire aircraft has been fluid purged as prescribed in paragraph 5-4, and all fuel cells/tanks have been drained to the fullest extent practical (including all fuel lines), depuddled and



mopped out, and when an LEL of 5% or less is maintained in all accessible, open fuel cells/tanks (verified as required by paragraph 5-4) then:

- a. Non-fuel and fuel cell repair maintenance can occur simultaneously.
- b. If all hazards are eliminated (and documented) i.e., no mechanical, electrical, chemical, or atmospheric hazard, no permit will be required to enter fuel tanks. The use of respiratory protection may still be required to prevent exposure to specific substances in accordance with other health standards. An atmosphere which could have health effects from exposure but will not cause incapacitation or limit the ability for self-rescue is not considered a hazardous atmosphere for a confined space.
- c. Fuel cell/tank repair can be performed by two people. One individual will enter tank/cell. The second will serve as an attendant to monitor activity around the entered tank and to maintain contact with the individual in the tank/cell. An attendant may monitor more than one tank/cell provided he or she can effectively maintain communication with all personnel in the tanks/cells and can easily summon help in the case of an emergency.
- d. The use of non-intrinsically safe equipment is permissible.
- e. If power is to be applied with open fuel tanks/cells or persons in the fuel tanks/cells the following must be done.
  - (1) All potential energy sources that could present hazards to personnel or equipment must be eliminated.
  - (2) Procedures for eliminating these hazards shall be coordinated through the ALC Safety Office.
- f. Protective equipment and respiratory protection will be used as prescribed by each ALC BES and Safety office.

## 2-12 CHECKLIST.

2-12.1 General Checklist for Tank Entries. Field Permits are not issued for any specific time-frame. The following checklist is provided for use at the beginning of each shift (or more often as deemed

necessary) over which a permitted entry task or other non-tank entry repair is performed.

- a. Check that a Field Permit is issued and complied with (Oxygen checked, LEL checked, rescue notified, etc).
- b. Check aircraft safe for maintenance.
- c. Check personal protective equipment available and serviceable.
- d. Check required personnel on-scene and in position.
- e. Check required warning signs posted.
- f. Ensure only authorized personnel are in area.
- g. Turn on and check ventilation and climate control equipment, as necessary.
- h. Check communication equipment.
- i. Check fire alarm systems.
- j. Turn on and check combustible gas and toxic alarm system if applicable. Calibrate as necessary.
- k. Check all support equipment properly positioned, serviceable and bonded to the aircraft.
- l. Check only authorized tools/equipment to be used in tank.
- m. Notify fire department when fuel system repair is to begin.
- n. Check that all hand tools required for fuel area maintenance are carried in a nonmetallic container.
- o. Check that maintenance is not accomplished on the aircraft while inerting, depuddling and purging operations are being accomplished.
- p. Check that a fire-safe condition (20% LEL or less) is maintained (10% LEL or less (20% for foam removal). Stop purging or depuddling operations on aircraft when thunderstorm/lightning is within a five-mile radius of the work area.
- q. Check that required fire extinguishers are ready for use.
- r. Deleted.
- s. Ensure that test/support equipment which is attached to the aircraft has "Remove Before Flight" and/or "Remove Before Fueling/Defueling" streamers attached.

- t. Ensure shift supervisors or designated representative is conducting a safety inspection of repair areas at the beginning of each shift.

2-12.2 General Checklist for Fuel Repair Area or Facility. Each fuel systems repair area shall have a checklist, work sheet or job guide available for use. The following checklist is provided to cover general procedures that are required to position an aircraft in a fuel system areas and prepare the aircraft for maintenance or tank entry. This checklist is general in nature and is not intended to cover peculiarities of individual aircraft or facilities. Therefore, a specific aircraft or fuel system checklist should be used if available.

#### NOTE

Aircraft serviced with JP-4, requiring tank/cell entry shall be defueled as required before being placed in a fuel system repair area. Defueling may be accomplished in an open repair area.

- a. Ensure shift supervisors or designated representative is conducting a safety inspection of repair areas at the beginning of each shift.
- b. Review aircraft 781 forms and brief personnel.
- c. Check that egress system and fire bottles are made safe and ensure all munitions are removed/downloaded.
- d. Check that all aircraft batteries are disconnected or made safe in accordance with the system peculiar technical order and tagged as required.
- e. Check that the aircraft external power receptacles and fuel control panel are tagged with AF Form 979 or 1492.
- f. Check that open areas are clear and properly identified.
- g. Check that required fire extinguishers are ready for use.
- h. Deleted.
- i. Check that the fire department has been notified.
- j. Check that emergency communications is established.

- k. Check that a fresh water supply is available for eye wash emergency.
- l. Check floor drains to make sure they are open and turn on exhaust fans.
- m. Check fuel spillage storage tank level.
- n. Check to make sure water flush valves operate.
- o. Ensure all support equipment used within the fuel cell repair area is bonded to the aircraft.
- p. Ensure that tool boxes that are mounted on rubber wheels or mats only are brought into the fuel cell repair area.
- q. Check personnel for proper clothing, equipment and removal of jewelry and spark/ flame producing devices prior to entry into the fuel system repair area.
- r. Ensure that personnel are checking/ inspecting their shoes for exposed tacks or metal prior to entering a fuel system repair area.
- s. Position the aircraft in an approved fuel systems repair area or facility.
- t. Check that the aircraft is properly bonded in accordance with applicable aircraft technical manuals.
- u. Check that the aircraft is parked, chocked and moored as per applicable aircraft technical manuals.



## SECTION III

### AIRCRAFT FUEL SYSTEMS MAINTENANCE

#### FACILITIES AND AREAS

##### 3-1 GENERAL.

The use of segregated facilities and areas for fuel systems repair is essential for safe and efficient fuel systems maintenance operations. These facilities provide a safer place to perform fuel system repair and provide the needed climatic conditions to ensure quality fuel systems maintenance. The areas and facilities described in this section provide necessary protection for both the aircraft and personnel from a variety of hazards.

WARNING

- This section is not intended to be used as design criteria for facility construction. The requirements of this section are extracted from referenced documents or provided by safety and civil engineering functions. Use of this section as a design document could cause serious injury or mission impairment.
- Use of a facility which does not meet the requirements of the applicable design criteria could create a fire hazard risk. Permanent waivers to fire protection requirements shall be approved in accordance with ETL 96-1. Temporary waivers to fire protection requirements until corrections can be made may be approved by the MAJCOM fire protection engineer (or MAJCOM fire protection manager in the absence of a MAJCOM fire protection engineer (refer to paragraph 3-1.2.1)).

**3-1.1 Permitted Operations.** Fuel system maintenance facilities are intended to support the complete range of operations related to fuel system maintenance including those normally restricted from being conducted inside hangars or other structures. These normally restricted operations, which are permitted in fuel system maintenance facilities, include but are not limited to: Partial and complete defuel/refuel of aircraft; depuddling and purging of fuel tanks; cells and components;

fuel transfers within the aircraft; and pressurization testing.

**3-1.2 Approval.** Facilities and areas shall be designated and approved for fuel system maintenance use based on the requirements of this technical order.

**3-1.2.1** Facilities not meeting the requirements of this technical order may be approved based on an approved Wing/base corrective action plan coordinated through Wing/base Safety, LG/CC, and Civil Engineering (Fire Protection) by restricting some of the normally permitted operations listed above and implementing other actions until corrections can be made. The approved base corrected action plan shall include the Risk Assessment Code (RAC)/project code, proposed completion date, and proposed operating procedures. In the absence of MAJCOM policy directing otherwise, the corrected action plan shall be forwarded to the following agencies in the MAJCOM: Fire Protection, Ground Safety, and LG.

**3-1.2.2** Facilities may be temporarily approved for emergency or minor repairs in non-approved areas (except repairs that are performed in accordance with paragraph 2-7.10) by the LG/CC upon evaluation and concurrence by the Fuel Element Chief, Wing Safety, Fire Protection and Bio-Environmental. The use of temporary facilities should only be considered after priority of the mission and the availability of other facilities (primary fuel systems docks/repair facilities shall be utilized first). The use of a temporary facility shall be approved on a case-by-case basis. Temporary facility usage shall not be considered strictly for ease of maintenance (e.g., to prevent towing of aircraft), but should be considered only during peak workloads and to prevent mission degradation.

**3-1.3 Exceptions.** Fuel systems maintenance may be performed in any hangar on aircraft which have never been fueled or on aircraft which have been completely fluid purged and drained in accordance with this technical order

**3-1.4 New Facilities Requirements.** MIL-HDBK 1190, MIL-HDBK 1008 (current edition) and Engineering Technical Letter 96-1 Fire Protection Engineering Criteria - New Aircraft Hangars provide guidance for the construction of new fuel system maintenance facilities.

**3-1.5 Existing/Modified Facilities Requirements.** The requirements of this technical order shall be used to evaluate existing/modified fuel system maintenance facilities. For facilities not meeting these requirements refer to paragraph 3-1.2.1.

**3-1.5.1** When facilities must be converted to permit fuel system maintenance activities or major improvements to an existing facilities, improvements will be based on the requirements of paragraph 3-1.4.

**3-1.6 Temporary Facilities.** The requirements of this technical order shall be used to evaluate existing facilities for limited use as a fuel system maintenance facility.

**3-1.7 Open (Outside) Fuel Systems Repair Areas.** The requirements of this technical order shall be used to evaluate outside areas for fuel system maintenance.

## **3-2 FUEL SYSTEM REPAIR FACILITIES REQUIREMENTS.**

**3-2.1 New Facilities.** All new fuel system maintenance facilities shall provide:

**3-2.1.1** As a minimum, if not a separate structure, the fuel system maintenance facility must be separated from all other areas of the building by not less than a one-hour masonry fire resistive construction.

**3-2.1.2** An operational fire suppression system suitable for aircraft hangar operations and wet pipe sprinklers in all adjacent areas. For fighter type aircraft provide at least a complete automatic overhead water deluge, foam-water deluge, closed-head pre-action foam-water, wet pipe foam-water, or high expansion foam system. For large frame aircraft provide one of the previous systems and an under aircraft fixed or automatic oscillating foam-water nozzle system.

**3-2.1.3** Emergency eye wash fountains and personnel showers shall be provided.

**3-2.1.4** Flightline type 150 lb. HALON 1211 wheeled fire extinguishers shall be provided. Existing installed HALON 1211 systems with wall mounted hose reels are acceptable alternatives to the wheeled fire extinguishers.

**3-2.1.5** Forced air heating supplied by steam or hot water heating will be provided throughout the facility. Radiant tube heating systems may be used in the aircraft maintenance area, if the flame is contained in a sealed chamber with combustion air taken from outside the aircraft maintenance area and combustion products exhausted outside the aircraft maintenance area.

**3-2.1.6** Aircraft maintenance area, tank exhaust, and trench ventilation/ exhaust systems are required to meet current bio-environmental instructions for personnel safety.

**3-2.1.7** Climatic Control Units (CCU) are required to provide environmentally stable air for air purging, sealant curing and general maintenance.

**3-2.1.8** Sufficient grounding points provided throughout the facility.

**3-2.1.9** Electrical systems shall have the following:

**3-2.1.9.1** Class I, Division 1, below the floor level, Class I, Division 1, through out foam/cell rooms, Class I, Division 2, through-out the hangar aircraft maintenance area up to 18 inches and Class I, Division 2, within 5 feet of the aircraft, and all wall mounted outlets and switches Class I, Division 2.

**3-2.1.10** Office space, break room, support equipment/tool room, and restrooms with climate control and ventilation to prevent fumes and vapors from migrating from the aircraft maintenance area. Rooms shall also be provided for tele-communications, utility/mechanical, and fire protection systems.

**3-2.1.11** Shop space including foam/cell rooms to service/repair fuels system components as required for the specific aircraft(s) maintenance.

**3-2.2 Existing Definitive Facilities.** Existing structures designed specifically for fuel systems maintenance (commonly referred to as definitive docks) shall have the following:

**3-2.2.1** As a minimum, if not a separate structure, the fuel system maintenance facility must be separated from all other areas of the building by not less than a one-hour masonry fire resistive construction.

**3-2.2.2** An operational fire suppression system suitable for aircraft hangar operations and wet pipe sprinklers in all adjacent areas. For fighter type aircraft provide at least a complete automatic overhead water deluge, foam-water deluge, closed-head pre-action foam-water, wet pipe foam-water, or high expansion foam system. For large frame aircraft provide one of the previous systems and an under aircraft fixed or automatic oscillating foam-water nozzle system.

**3-2.2.3** Emergency eye wash fountains and personnel showers shall be provided.

**3-2.2.4** Flightline type 150 lb. HALON 1211 wheeled fire extinguishers shall be provided.

Existing installed HALON 1211 systems with wall mounted hose reels are acceptable alternatives to the wheeled fire extinguishers.

3-2.2.5 Forced air heating supplied by steam or hot water heating will be provided throughout the facility. Radiant tube heating systems may be used in the aircraft maintenance area, if the flame is contained in a sealed chamber with combustion air taken from outside the aircraft maintenance area and combustion products exhausted outside the aircraft maintenance area.

3-2.2.6 Aircraft maintenance area, tank exhaust and trench exhaust/ventilation systems required to meet current bio-environmental instructions for personnel safety.

3-2.2.7 Climatic Control Units (CCU) required to provide environmentally stable air for air purging, sealant curing and general maintenance.

3-2.2.8 Sufficient grounding points provided throughout the facility.

3-2.2.9 Electrical systems shall meet one of the following criteria depending upon when facility was constructed:

3-2.2.9.1 Class I, Division 1, below the floor level, Class I, Division 1, through out foam/cell rooms, Class I, Division 2, through out the hangar aircraft maintenance area up to the height of the hangar door and Class I, Division 2, up to 18 inches above the floor in all adjacent areas not suitably cut off from the hangar aircraft maintenance area.

3-2.2.9.2 Class I, Division 1, through out foam/cell rooms, Class I, Division 1, below the floor level and through out the hangar aircraft maintenance area to 4 foot above the floor and Class I, Division 2, up to 18 inches above the floor in all adjacent areas not suitable cut off from the hangar aircraft maintenance area.

3-2.2.10 Office space, break room, support equipment/tool room, and restrooms with climate control and ventilation to prevent fumes and vapors from migrating from the aircraft maintenance area. Rooms shall also be provided for tele-communications, utility/mechanical, and fire protection systems.

3-2.2.11 Shop space including foam/cell rooms to service/repair fuels system components as required for the specific aircraft(s) maintenance.

3-2.3 Existing Modified Facilities. Existing facilities modified for limited fuel systems maintenance (commonly referred to as modified docks) shall have the following:

3-2.3.1 As a minimum, if not a separate structure, the fuel system maintenance facility must be separated from all other areas of the building by not less than a one-hour masonry fire resistive construction.

3-2.3.2 An operational fire suppression system suitable for aircraft hangar operations and wet pipe sprinklers in all adjacent areas. For fighter type aircraft provide at least a complete automatic overhead water deluge, foam-water deluge, closed-head pre-action foam-water, wet pipe foam-water, or high expansion foam system. For large frame aircraft provide one of the previous systems and an under aircraft fixed or automatic oscillating foam-water nozzle system.

3-2.3.3 Emergency eye wash fountains and personnel showers shall be provided.

3-2.3.4 Flightline type 150 lb. HALON 1211 wheeled fire extinguishers shall be provided. Existing installed HALON 1211 systems with wall mounted hose reels are acceptable alternatives to the wheeled fire extinguishers.

3-2.3.5 Forced air heating supplied by steam or hot water heating will be provided throughout the facility. Radiant tube heating systems may be used in the aircraft maintenance area, if the flame is contained in a sealed chamber with combustion air taken from outside the aircraft maintenance area and combustion products exhausted outside the aircraft maintenance area.

3-2.3.6 Aircraft maintenance area and tank exhaust systems required to meet current bio-environmental instructions for personnel safety and health.

3-2.3.7 Climatic Control Units (CCU) or approved portable support equipment required to provide environmentally stable air for air purging, sealant curing and general maintenance.

3-2.3.8 Sufficient grounding points provided throughout the facility.

3-2.3.9 Electrical systems shall meet one of the following criteria depending upon when facility was constructed:

3-2.3.9.1 Class I, Division 1, below the floor level, Class I, Division 1, throughout foam/cell rooms, Class I, Division 2, through out the hangar aircraft maintenance area up to the height of the hangar door and Class I, Division 2, up to 18 inches above the floor in all adjacent areas not suitable cut off from the hangar aircraft maintenance area.

3-2.3.9.2 Class I, Division 1, throughout foam/cell rooms, Class I, Division 1, below the floor

level and through out the hangar aircraft maintenance area to 4 foot above the floor and Class I, Division 2, up to 18 inches above the floor in all adjacent areas not suitably cut off from the hangar aircraft maintenance area.

3-2.3.10 If used office space, break room, support equipment/tool room, and restrooms will have climate control and ventilation to prevent fumes and vapors from migrating from the aircraft maintenance area.

#### 3-2.4 Temporary Repair Facilities Requirements.

3-2.4.1 All aircraft fuel tanks (to be worked) shall be defueled and initially drained prior to entry into facility. Additional draining shall be accomplished using approved drain containers/methods. Temporary facility doors shall remain open during tank purging and depuddling operations until a entry safe condition is reached and maintained.

3-2.4.2 Only equipment approved for fuel systems maintenance will be used in temporary facilities.

3-2.4.3 Exhaust ducts shall be positioned outside the facility doors, and positioned to prevent fuel fumes from traveling back into the facility. These ducts will be marked off an additional 50 foot radius from the end of the duct.

3-2.4.4 All safety requirements outlined in section II of this Technical Order shall be met prior to using a temporary facility.

3-2.4.5 Any adjoining offices shall be isolated/evacuated during fuel systems maintenance to prevent unauthorized entry and endangerment of personnel not associated with the on-going fuel systems maintenance. Controlled entry into the area is paramount.

3-2.4.6 Fuel transfer, defuel or refuel operations shall not be accomplished in a temporary facility.

#### 3-3 OPEN (OUTSIDE) FUEL SYSTEM REPAIR AREA REQUIREMENTS.

3-3.1 An open fuel system repair area is any area that has been approved by the LG/CC with coordination from the Fuel Systems Element Chief, Wing Safety, Bio-environmental, Fire Protection and the Airfield Manager to perform aircraft fuel systems repairs in an open/outside area.

3-3.1.1 The area shall be marked off in accordance with Section II of this manual. An additional 50-feet may be required if exhaust purge is used (refer to paragraph 2-7.7.4).

3-3.1.2 The fuel systems work accomplished in an outside area is highly dependent upon weather

conditions and available authorized portable equipment. All portable electrical equipment and connections used in hazardous areas shall meet the requirements of the NEC for Class I, hazardous locations.

3-3.1.3 All outside areas shall be equipped with at least two 150 pound HALON 1211 fire extinguishers. Additional extinguishers shall be provided as required by the base fire Marshall.

3-3.1.4 Adjacent aircraft shall not be allowed to operate under their own power within 100 feet of the repair area (refer to paragraph 2-7.9). They shall also be limited from operations where jet blasts or noise factors could affect safety as outlined in Section II of this T.O. and the applicable aircraft systems technical orders.

3-3.1.5 Portable eye wash must be available at the job site.

#### 3-4 OPERATIONS.

3-4.1 Fuel systems repair facilities and areas shall: be kept clean, maintained in good repair, and be off limits to non-essential personnel. The areas and facilities shall be inspected at the start of each shift and more often as deemed necessary to ensure safe working conditions are maintained. Due to the non-standard equipment installed in some facilities, the Fuel Element Chief shall ensure operating, inspection, and maintenance instructions are available and followed for equipment installed in facilities.

3-4.2 The storage of materials or non-fuel system equipment in the maintenance area increases the risk of fire and unnecessarily complicates fire fighting operations. Materials should be stored in equipment or tool rooms. Equipment not used for fuel system maintenance will not routinely be stored in the maintenance area. Should local conditions necessitate the use of the maintenance area for equipment storage.

3-4.2.1 Fire Department, Ground Safety, and the Fuel Element Chief will concur to the storage.

3-4.2.2 All batteries will be disconnected and terminals tagged. No batteries shall be connected or disconnected during periods of open-tank maintenance. Keys will be secured in the Element Chief's office.

3-4.2.3 Sufficient space will remain around the aircraft to permit egress and eliminate hazards.

3-4.2.4 Equipment will not be parked under the shadow of the aircraft or within a 10-foot radius of fuel vents or tank openings.

3-4.2.5 Emergency communications will be established with the maintenance control center (or equivalent) from the job site.

Table 3-1. Recommend Facility Pump Performance Criteria

<u>MARK</u>	<u>AREA USUALLY SERVED</u>	<u>G.P.M.</u>	<u>HEAD</u>	<u>H.P.</u>	<u>R.P.M.</u>
Pump 1	Heating Water #1 (Heating Ventilating Unit 1, 2, 3)	256	67 ft	7.5	1750
Pump 2	Heating Water #2 (Heating Ventilating Unit 4)	6	29 ft	0.75	1750
Pump 3	Heating Water #3 (Climate Control Unit)	118	43 ft	3.0	1750
Pump 4	Heating Water #4 (Snow Melting Pad)	40	57 ft	1.5	1750
	Converter Water Circulator	60	11 ft	0.25	1750

Table 3-2. Recommend Facility Fan Performance Criteria

<u>TYPE</u>	<u>CFM AT 70°</u>	<u>S.P.M. IN H<sub>2</sub>O</u>	<u>RPM</u>	<u>H.P.</u>	<u>ENTERING AIR °F</u>
Axial Flow (Trench Exhaust)	20,400	1.5 inch	1320	10.0	50
Centrifugal (Wing Exhaust)	4,000	1.5 inch	1780	2.0	105
Centrifugal (Constant Purge)	2,500	0.75 inch	670	0.75	50
Wall Exhaust (Office Area)	460	0.25 inch	1550	0.067	90



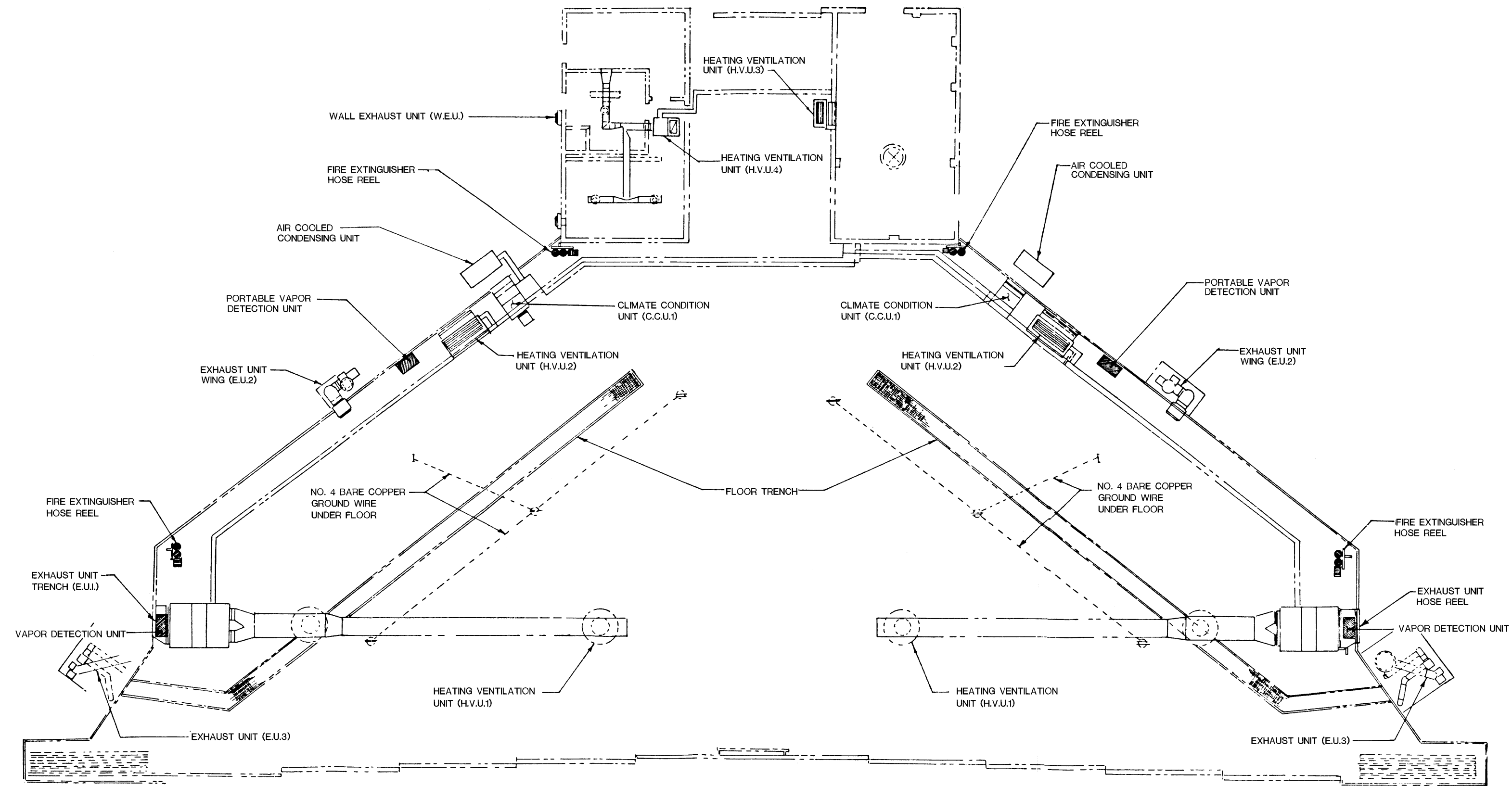
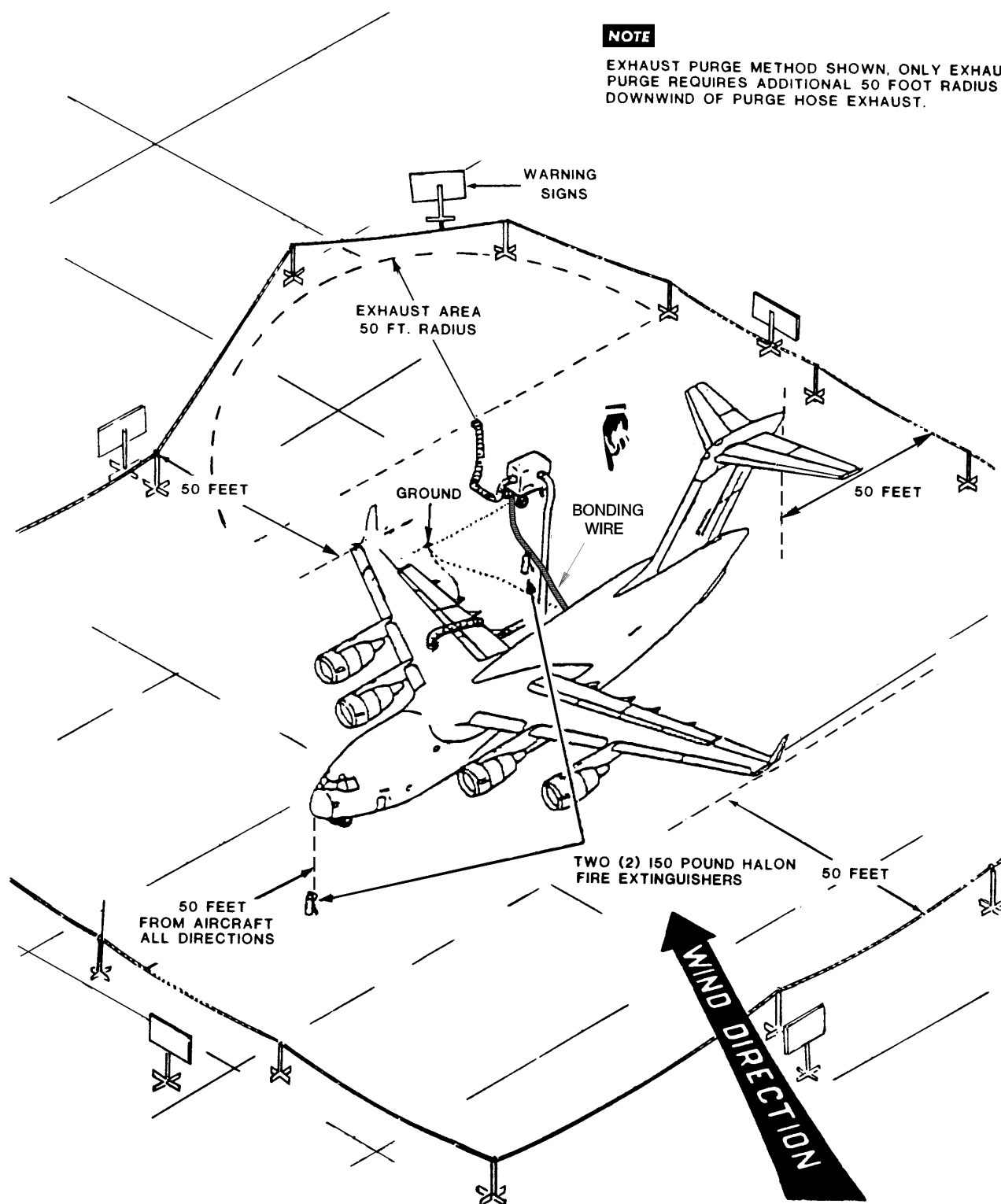


Figure 3-1. Typical Aircraft Fuel System Maintenance Dock



**NOTE**

EXHAUST PURGE METHOD SHOWN, ONLY EXHAUST  
PURGE REQUIRES ADDITIONAL 50 FOOT RADIUS  
DOWNWIND OF PURGE HOSE EXHAUST.



L9101124

Figure 3-2. Exhaust or Blow Purge Open Area Typical



## SECTION IV

### FUEL LEAK EVALUATION, CLASSIFICATION, DOCUMENTATION AND TEMPORARY REPAIRS

#### 4-1 PURPOSE.

This section provides information on evaluating, classifying, documenting, applying temporary repairs, and removing temporary repairs to fuel leaks occurring in integral tanks.

#### 4-2 GENERAL.

4-2.1 Fuel leaks should only be repaired when the leak threatens the airworthiness of the aircraft. Applying temporary repairs to leaks to maintain the cosmetic appearance of an aircraft is not necessary and may prove to be a labor intensive operation. As a general rule when fuel develops a leak path the fuel will travel the path of least resistance to the exterior of the aircraft. When a temporary repair is accomplished the leak path can continue to the next available exit point, at which point another temporary repair is usually accomplished. If this pattern is noted the only way to stop the leak is to apply a repair to the leak source (permanent repair).

4-2.2 Proper fuel leak evaluation and classification is necessary to determine if an aircraft is airworthy. This is accomplished by locating the leak exit point (evaluation) and monitoring the rate at which is leaking from the cell or tank (classification). Possible sources for leaks are tanks, cells, ferry tanks, fuel lines, and accessories. For leakage limits and repair or replacement procedures for external tanks, ferry tanks, fuel lines and accessories refer to the system or commodity technical order. Methods approved to locate leak exit points are: talcum powder, pressure test and gas detection method. The talcum powder method has proven to be the quickest and most cost effective method for detecting leaks. The other methods are normally used when permanent repairs are required and are discussed in Section VI.

4-2.3 In general higher flashpoint fuels (JP-5 or JP-8) are more prone to exhibit signs of leakage. The tendency to drip becomes more pronounced at lower temperatures. For leak hazard purposes civil airline Jet A and Jet A-1 are considered

equivalent to JP-8 and civil airline fuel Jet B is equivalent to JP-4.

#### 4-3 CAUSES OF FUEL LEAKS.

Fuel leaks are caused by a variety of different reasons, all of which cause considerable expenditure of resources to correct and impact the mission capability of the aircraft. Common causes for leaks are material deficiencies, structural cracks, corrosion, improper manufacturing and maintenance procedures.

#### 4-4 LOCATING LEAK EXIT POINTS.

4-4.1 Red Talcum Powder Method. After a leak has been detected and before the tank has been defueled the red talcum powder method may be used to localize a leak exit point.

4-4.1.1 Materials needed: Clean, static-free absorbent wiping cloths, marking pencil and either red leak detection talcum powder and thick bristled animal hair (example: camel or goat) brush or red aerosol leak detection talcum powder.

##### 4-4.1.2 Procedures.

- a. Strip exterior sealants from seams in suspected leak areas.
- b. Blow out all seams and corners with compressed air (30 psi maximum) and wipe area dry. Change cloths as often as necessary to ensure area is completely dry.
- c. Dust area with leak detection talcum powder immediately.
- d. Observe dusted area in order to locate leak point. The powder which contacts fuel will turn bright red. Mark leak point with marking pencil. Continue observing and mark additional leak points.
- e. Wipe remaining talcum powder, being careful not to remove leak point marks.
- f. Continue leak path analysis.

Table 4-1. Leak Classification Table - Integral Fuel Tanks

LEAK CATEGORY	SIX MINUTE LEAK LIMITS BY FUEL TYPE			LOCATION - CONDITION/ACTION			
	AVGAS	JP-4	JP-5/JP-8	EXTERNAL	INTERNAL VENTED	INTERNAL NON-VENTED	Electrical conduit/ External mounted Components
Class "A" Slow Seep	0 to 1/4 inch	0 to 1/4 inch	0 to 1/4 inch	1	1	1 (2 places)	4
Class "B" Seep	greater than 1/4 to 3/4 inch	greater than 1/4 to 3/4 inch	greater than 1/4 to 3/4 inch	1	2 (2 places max)	3	4
Class "C" Heavy Seep	greater than 3/4 to 2 inches without dripping	greater than 3/4 to 6 inches without dripping	greater than 3/4 to 8 inches and/or less than 4 drops minute	2	3	3	4
Class "D" Running Leak	greater than 2 inches or drips or runs from surface	greater than 6 inches or drips or runs from surface	greater than 8 inches or 4 drops/minute	3	3	3	4

#### 4-5 INTEGRAL TANK LEAK CLASSIFICATION.

4-5.1 Each leak shall be thoroughly evaluated and the surrounding area investigated prior to classification. Wipe the area dry using a clean, static free absorbent cloth. Forced air (not to exceed 30 psi) may be used to assist drying process. Allow six minutes for leak to develop. The size of the wetted area around the leak exit point is an accurate method to classify fuel leakage. Leak detection powder may be applied to assist in classifying leaks.

4-5.2 Table 4-1 and the following shall be used for integral fuel tank leak classification:

4-5.2.1 Leak Categories. Leak categories are denoted as Class A through D. Surface irregularities may localize fuel and result in dripping even though leak is a seep or heavy seep. In such cases, judgement must be used in relating the speed with which fuel reappears and spreads after wiping to

determine category of leak. When in doubt classify leak to higher leak category for repair determination.

4-5.2.2 Leak Limits. Leak limits are provided for the most common Air Force aviation fuels. Mixtures of JP-4 with JP-5 and/or JP-8 shall be classified using the criteria for JP-4.

4-5.2.3 Location. Leak location is used to determine which condition/action is required.

- External - Those areas exposed to air or air flow when flying, such as upper or lower wing surfaces and exposed fuselage surfaces. Areas that are not considered external are those surfaces exposed to air flow only when extended, such as flaps, slats etc.
- Internal Vented - Those areas that are vented while flying or while the aircraft is on the ground. Examples are front and

rear spars or dry bays that are drained and ventilated to the atmosphere.

- c. Internal Non-Vented - Those areas that are normally adjacent to fuel tanks or fuel lines and have no means of air circulation even though they may be drained (e.g., weep holes).
- d. Electrical Conduit - Conduits which route electrical wiring through fuel tanks to any components.
- e. External Mounted Components. Components mounted outside a tank.

4-5.2.4 Condition/Action: The following conditions/actions are minimum requirements. Leaks, however, may always be repaired back to a no leak condition.

- a. Condition 1 - Document the leak and periodically inspect for growth to condition 2 or 3. No repair is necessary, may be repaired when tank is opened for inspection or repair.
- b. Condition 2 - Document and periodically inspect for growth to condition 3. No repair is required. Schedule repair when aircraft is down for maintenance, when tank is opened for inspection or repair, or in accordance with appropriate aircraft technical order.
- c. Condition 3 - Document and repair to no leakage or back to condition 1 or 2 in accordance with the appropriate technical order. If leak cannot be repaired back to a condition 1 or 2 the aircraft shall be grounded until leaks are repaired.
- d. Condition 4 - Do not repair by applying sealants externally or by using other temporary repair procedures. Correct discrepancy by repairing or replacing affected component. Aircraft shall be grounded until repair is complete.

4-5.3 Integral tank leaks shall be repaired using either the temporary repair methods (paragraph 4-8.) or by applying permanent repairs in accordance with Section VI.

#### 4-6 FUEL CELL LEAK EVALUATION.

4-6.1 Any leakage from the cavity drain shall be investigated. Aircraft with fuel leaks from fuel cell cavities to adjoining dry bay(s) shall be documented and the aircraft grounded until the leak source is determined and repair action accomplished. Fuel cells shall be repaired or replaced in accordance with Section VII.

#### 4-7 DOCUMENTATION.

4-7.1 Any integral fuel tank leak shall be annotated on the AFTO Form 781A or 781K (manual or automated). All leaks shall be annotated on the aircraft AFTO Form 427 or 428, unless the aircraft specific technical orders state otherwise. After a permanent repair is accomplished the AFTO Form 427 or 428 shall be maintained for a historical record. After permanent repairs are accomplished clear the entry on AFTO Form 781. Aircraft historical documents shall be consulted when fuel systems maintenance is to be performed. Documents shall accompany aircraft to depot or contractor repair or when the aircraft is transferred. Leaks and repairs shall be entered in maintenance data collection systems, e.g., CAMS, as required.

#### 4-8 INTEGRAL TANK TEMPORARY REPAIRS.

4-8.1 Temporary repairs are used to downgrade leak classifications to a flyable condition until such time permanent repairs can be accomplished. Temporary repairs should be replaced with permanent repairs when the aircraft is grounded and the tanks are opened for inspection or other maintenance. Temporary repairs are applied to the leak exit point and usually do not require tank entry. If a particular method of temporary repair repeatedly fails for a particular leak a permanent repair shall be accomplished. Suspected loose fasteners will be permanently repaired by replacing fasteners at the earliest possible date. Any leak at an interference fit fastener will be treated as a loose fastener and replaced at the earliest possible date, to ensure wing structural integrity. Temporary repairs accomplished during depot or contractor programmed depot maintenance (PDM) repair shall be removed and permanent repairs accomplished prior to release of aircraft to the using organization. Temporary repairs accomplished during delivery preparation phase of PDM shall be allowed to remain provided the repairs do not exceed one per tank.

4-8.2 The repairs of this section shall not be used to mask, or repair leaks caused by, structural damage, corrosion or component failure.

4-8.3 Approved methods of temporary repair, in order of preference, are:

- a. Hardman extra-fast setting epoxy with aluminum foil patch (paragraph 4-8.4.)
- b. Aluminum foil patch bonded with sealant (paragraph 4-8.5.)
- c. Epoxy tabs (paragraph 4-8.6.)
- d. Click patch (paragraph 4-8.7.)
- e. Sealant without aluminum foil patch (paragraph 4-8.8.)

- f. Hardman extra-fast setting epoxy without aluminum foil patch (paragraph 4-8.9.)
- g. Comp Air D-236 injector kit (paragraph 4-8.10.)
- h. Oylite Stik (paragraph 4-8.11.)

#### 4-8.4 Hardman Extra-Fast Setting Epoxy with Aluminum Foil Patch.

##### 4-8.4.1 Repair limitations/information:

- a. Temperature limits - +40° F to +120° F.
- b. Curing times - 40 minutes @ + 40° F, 15 minutes @ +120°F.
- c. Humidity - No effect.
- d. Adhesion - Epoxy adheres better to coating than to bare aluminum, therefore, do not remove coating.
- e. Accelerated Cure: Heat will cause the epoxy to become brittle, therefore do not use heating devices to accelerate cure time.
- f. Fuel Load - The aircraft does not need to be defueled for this procedure.

4-8.4.2 Materials required: Solvent (four part cleaner (MIL-C-3 8736), MEK or other solvents listed in Section VIII), clean, static-free absorbent wiping cloths, Hardman Extra-fast Setting epoxy, aluminum foil patch (0.002 inch thick).

##### 4-8.4.3 Application procedure.

- a. Cut a patch from the foil that will extend 1/4-inch beyond the fastener.
- b. Clean the surface of the patch to which adhesive will be applied and area around fastener with solvent.
- c. Mix epoxy in accordance with manufacturer's instructions. Coat cleaned side of patch with 0.015 to 0.020 inch epoxy.
- d. Press patch in place over fastener head.

##### 4-8.4.4 Removal.

- a. Using a heat gun, heat patch to 200°F to 250°F. Temperatures below 200°F will not soften epoxy. Temperatures above 250°F will damage aircraft paint system.
- b. While patch is hot use a plastic scraper to pry up part of patch. Continue to apply heat and use needle-nose pliers to remove patch.
- c. Reheat area and use plastic scraper to remove remaining epoxy.

#### 4-8.5 Aluminum Foil Patch Bonded with Sealant.

4-8.5.1 Materials required: Solvent (four part cleaner (MIL-C-38736), MEK or other solvent listed in Section VIII), clean, static-free absorbent wiping cloths, sealant (MIL-S-8802, Class B or MIL-S-83430, Class B), aluminum foil patch (0.002 inch thick) and heat gun.

##### 4-8.5.2 Repair limitations/information:

- a. Temperature limits - None, when heating device from kit are used.
- b. Curing times - 40 minutes @ + 140° F (temperature of heating device in repair kit).
- c. Humidity - Refer to tack free times (Table 6-2) for effect of humidity on cure times.
- d. Adhesion - At low temperatures (50° F and below), better results are obtained if area around fastener is preheated for a few minutes.
- e. Accelerated Cure: Not applicable.
- f. Fuel Load - For best results the aircraft should be defueled below the leak exit point.

##### 4-8.5.3 Application procedure.

- a. Cut a patch from the foil that will extend 1/4-inch beyond the fastener.
- b. Clean the surface of the patch to which adhesive will be applied and area around fastener with solvent.
- c. Coat cleaned side of patch with 0.015 to 0.020 inch sealant.
- d. Press patch in place over fastener head.
- e. Using heating device apply heat to patch for approximately 30 minutes.

##### 4-8.5.4 Removal

- a. Cut sealant under edge of patch with a plastic scraper.
- b. Pull patch back and continue cutting until sealant and patch are removed.

#### 4-8.6 Epoxy Tabs or Putty.

4-8.6.1 Materials required: Solvent (four part cleaner (MIL-C-38736), MEK or other solvent listed in Section VIII), clean, static-free absorbent wiping cloths, epoxy putty or epoxy tab Type-O.

##### 4-8.6.2 Repair limitations/information:

- a. Temperature limits - None.
- b. Curing times - Approximately two minutes.
- c. Humidity - No limitations.

- d. Adhesion - Scuff sanding may help adhesion.
- e. Accelerated Cure: Not applicable.
- f. Fuel Load - The aircraft does not need to be defueled for this procedure.

#### 4-8.6.3 Application procedure.

- a. Clean the area around fastener with solvent.
- b. Mix epoxy according to manufacturer's instructions.
- c. Apply ample amount epoxy over fastener. Feather edges to approximately 1/4-inch beyond edge of fastener. Remove excess epoxy.

#### 4-8.6.4 Removal.

- a. Place a plastic scraper at edge of repair.
- b. Tap scraper with rubber mallet until repair pops off.

#### 4-8.7 Click Patch.

##### 4-8.7.1 Materials required: Click patch kit.

##### 4-8.7.2 Repair limitations/information:

- a. Temperature limits - Refer to information for type of adhesive used.
- b. Curing times - Refer to information for type of adhesive used.
- c. Humidity - Refer to information for type of adhesive used.
- d. Adhesion - Refer to information for type of adhesive used.
- e. Accelerated Cure - Refer to information for type of adhesive used.
- f. Fuel Load - The aircraft does not need to be defueled for this procedure.

##### 4-8.7.3 Application procedure. Use contents of kit in accordance with manufacturer's instructions.

##### 4-8.7.4 Removal.

- a. For sealant adhesive type patches:
  - (1) Cut sealant under edge of patch with a plastic scraper.
  - (2) Pull patch back and continue cutting until sealant and patch are removed.
- b. For epoxy adhesive type patches:
  - (1) Using a heat gun, heat patch to 200° F to 250° F. Temperatures below 200° F will not soften epoxy. Temperatures

above 250° F will damage aircraft paint system.

- (2) While patch is hot use a plastic scraper to pry up part of patch. Continue to apply heat and use needle-nose pliers to remove patch.

- (3) Reheat area and use plastic scraper to remove remaining epoxy.

#### 4-8.8 Sealant Without Aluminum Foil Patch.

4-8.8.1 Materials required: Solvent (four part cleaner (MIL-C-38736), MEK or other solvent listed in Section VIII), clean, static-free absorbent wiping cloths, sealant (MIL-S-8802, Class B, or MIL-S-83430, Class B), and heat gun.

##### 4-8.8.2 Repair limitations/information:

- a. Temperature limits - None, when heating device from kit are used.
- b. Curing times - 40 minutes @ + 140° F (temperature of heating device in repair kit).
- c. Humidity - Refer to tack free times (Table 6-2) for effect of humidity on cure times.
- d. Adhesion - At low temperatures (50° F and below), better results are obtained if area around leak exit point is preheated for a few minutes.
- e. Accelerated Cure: Not applicable.
- f. Fuel Load - For best results the aircraft: should be defueled below the leak exit point.
- g. Other Limits - This method should only be used on non-pressurized fuel tank surfaces.

##### 4-8.8.3 Application procedure.

- a. Clean the surface of which sealant will be applied.
- b. Apply a thin coat of sealant to leak exit point.
- c. Using heating device apply heat for approximately 30 minutes.

##### 4-8.8.4 Removal.

- a. Cut sealant off with a plastic scraper.

#### 4-8.9 Hardman Extra-Fast Setting Epoxy Without Aluminum Foil Patch.

##### 4-8.9.1 Repair limitations/information:

- a. Temperature limits - +40° F to +120° F.
- b. Curing times - 40 minutes @ + 40° F, 15 minutes @ +120° F.

- c. Humidity - No effect.
- d. Adhesion - Epoxy adheres better to coating than to bare aluminum, therefore, do not remove coating.
- e. Accelerated Cure: Heat will cause the epoxy to become brittle, therefore do not use heating devices to accelerate cure time.
- f. Fuel Load - For best result defuel aircraft: below leak exit point.
- g. Other Limits - This method should only be used on non-pressurized fuel tank surfaces.

4-8.9.2 Materials required: Solvent (four part cleaner (MIL-C-38736), MEK or other solvent listed in Section VIII), clean, static-free absorbent wiping cloths, Hardman Extra-fast Setting epoxy.

#### 4-8.9.3 Application procedure.

- a. Clean the area to which adhesive will be applied with solvent.
- b. Mix epoxy in accordance with manufacturer's instructions.
- c. Apply a thin coat of epoxy to leak exit point.

#### 4-8.9.4 Removal.

- a. Using a heat gun, heat epoxy to 200° F to 250° F. Temperatures below 200° F will not soften epoxy. Temperatures above 250° F will damage aircraft paint system.
- b. While epoxy is hot use a plastic scraper to remove epoxy.

4-8.10 Comp Air D236 Injector Kit. The injector forces sealant into the leaks at 900 psi.

#### 4-8.10.1 Repair limitations/information:

- a. Temperature limits - None.
- b. Curing times - Five to 10 minutes @ 150° F
- c. Humidity - Humidity does not effect cure time
- d. Adhesion - Paint must be removed from around leaking fastener.
- e. Accelerated Cure - Not applicable
- f. Fuel Load - The aircraft does not need to be defueled for this procedure.
- g. Other Limits - For use on leaks around flush type fasteners.

4-8.10.2 Materials required: Solvent (four part cleaner (MIL-C-38736), MEK or other solvent listed in Section VIII), clean, static-free absorbent

wiping cloths, Comp Air D236 Injector Kit, sealant (MIL-S-22437), aluminum foil tape.

#### 4-8.10.3 Application procedure.

- a. For leaks on lower wing surfaces:
  - (1) Preheat D236-14 heating iron to 150° F maximum. Remove paint from around fastener and clean with solvent.
  - (2) Position locator D236-12-2 over head of fastener and attach with suction cups.
  - (3) Attach D236-11 cylinder and D236-10 jack. Use extensions as necessary.
  - (4) Align complete assembly to be perpendicular to surface.
  - (5) Attached compressed air source to cylinder.
  - (6) Fill injector with sealant.
  - (7) Place injector through locator.
  - (8) Manually extend jack to force cylinder rod to retract into cylinder approximately three inches.
  - (9) Observe injector head. When all sealant has been injected the sleeve will line up with edge of body.
  - (10) Remove injector, wipe surface with cloth dampened with solvent.
  - (11) Apply aluminum foil tape, approximately one inch square, over fastener head.
  - (12) Hold heating iron firmly against tape for five to 10 minutes to cure sealant.
  - (13) Peel tape off.
- b. For leaks on upper wing surfaces. Preheat D236-14 heating iron to 150° F maximum. Remove paint from around fastener and clean with solvent.
  - (1) Place correct foot assembly over leak.
  - (2) Position locator D236-12-3.
  - (3) Fill foot with sealant.
  - (4) Install plunger in foot assembly.
  - (5) Press down on plunger to inject sealant.
  - (6) Remove injector, wipe surface with cloth dampened with solvent.
  - (7) Apply aluminum foil tape, approximately one inch square, over fastener head.

- (8) Hold heating iron firmly against tape for five to 10 minutes to cure sealant.

#### 4-8.10.4 Removal.

- a. Remove when final repairs are accomplished.

#### 4-8.11 Oylite Stik.

##### 4-8.11.1 Repair limitations/information:

- a. Temperature limits - None.
- b. Curing times - Immediate.
- c. Humidity - Humidity does not effect cure time.
- d. Adhesion - Not applicable
- e. Accelerated Cure: Not applicable
- f. Fuel Load - The aircraft: does not need to be defueled for this procedure.
- g. Additional Limitations. For use on leaking fasteners. May require touch-up paint after application.

4-8.11.2 Materials required: Solvent (four part cleaner (MIL-C-3 8736), MEK or other solvent listed in Section VIII), clean, static-free absorbent wiping cloths, Oylite Stik.

##### 4-8.11.3 Application procedure.

- a. Clean area with solvent.
- b. Soften Oylite Stik by dipping open end in solvent.
- c. Firmly apply Oylite Stik to fastener head. Repeat as necessary.
- d. Remove excess material.

##### 4-8.11.4 Removal.

- a. Remove when permanent repairs are accomplished.



## SECTION V

## PREPARATION FOR MAINTENANCE

## 5-1 PURPOSE.

This section provides instructions for preparing aircraft fuel tanks for maintenance and/or inspection.

WARNING

Aircraft purging, depuddling and inerting require that extreme precautions be taken to prevent fire, explosions or health hazards. Strict compliance with the safety and health requirements, instructions and checklist in Section II of this manual are mandatory.

## 5-2 GENERAL.

5-2.1 Descriptions and procedures for purging, depuddling, and inerting of aircraft fuel cells/tanks, with or without explosion suppression foam materials and the equipment/materials required to accomplish these tasks are described. Purging and depuddling may be accomplished in any Category III facility or fuel system maintenance area. Aircraft fueling/defueling, and mooring, shall be accomplished in accordance with the applicable aircraft manual. Electrical, egress, armament and other systems shall be made safe in accordance with Section II of this manual, the applicable aircraft manuals, and other general series manuals. Grounding and bonding shall be in accordance with Section II.

5-2.2 Aircraft, serviced with AVGAS or JP-4, requiring defueling, should be defueled prior to being towed into any fuel system repair facility. Fuel may be transferred between internal tanks to facilitate maintenance requirements; drained, depuddled or air purged when the aircraft is in open fuel system repair areas or Category III facilities.

## 5-3 PURGING METHODS.

## 5-3.1 GENERAL.

5-3.1.1 Purging is used to remove volatile fuel vapors from a cell/tank and reduce the LEL while retaining an acceptable percentage of oxygen in the tank. The two approved methods for purging are fluid purge and air purge. Aircraft which use

JP-5 or JP-8 may not, under certain circumstances, require purging and can have the LEL maintained at acceptable levels by ventilating the tank. Purging to an entry-safe condition (10% LEL (20% LEL for foam removal) or less) shall be attained prior to performing in-tank maintenance or inspections. If entry is not required the tank need only be purged to maintain a fire-safe condition (20 percent LEL). If a tank can maintain less than 10% LEL without airflow into or through the tank, the tank is considered acceptably purged. Tanks shall be continuously purged or ventilated during all entries.

5-3.1.2 Fluid Purge. (Depot Only) Fluid purge is flushing a fuel system with a fluid to remove flammable fuels which remain after defueling. Purging fluid MIL-F-38299 or jet fuel JP-5 or JP-8 may be used. All purge fluids shall maintain a minimum 120° F flashpoint. Aircraft serviced with JP-8 may require a fluid purge, with one of the other approved purge fluids, or an air purge if the proper flashpoint cannot be achieved/maintained. Typically if the temperature is above 75°F and the flashpoint of the JP-8 is 100°F the LEL may not remain below 20 percent at standard atmospheric pressures. When fluid purging it is not necessary to open access doors or other fittings. Continuous mechanical ventilation is required during all entries.

5-3.1.3 Air Purge. Air purge is the process of supplying fresh air to a fuel tank to reduce fuel vapors. Three approved types of air purge are combination, blow, and exhaust purge. The preferred method of air purge is a combination exhaust and blow purge. Exhaust purge is the process of exhausting the tank air (to a safe area) and pulling fresh air into the tank. Blow purge is the circulating (blowing) of fresh air into a tank. Air purge may be accomplished with installed and/or portable equipment. Air purge shall be continuous during all entries.

5-3.1.4 Ventilation. Ventilation is the process of supplying fresh air to a fuel tank once a tank is considered acceptably purged.

## 5-4 FLUID PURGE PROCEDURES.

## 5-4.1 MIL-F-38299 Purging Fluid Procedures.

5-4.1.1 Equipment and Materials Required. Equipment to fuel and defuel aircraft, purge fluid, safety containers, bowsers, oxygen analyzer, combustible vapor meter.

## 5-4.1.2 Procedure.

- a. Defuel aircraft in accordance with applicable manual.
- b. Open sumps and drains. Drain fuel into an approved safety container.

**WARNING**

The LEL of a tank purged with JP-8 may not remain under 20 percent if the ambient temperature exceeds 75° F at standard atmospheric pressures. If it is expected the temperature will exceed 75° F the tank should be purged with another fluid or air purged.

- c. If aircraft was fueled with JP-5 or JP-8 check oxygen level and LEL. If oxygen level is between 19.5 and 23.5 percent, check LEL. If LEL is less than 20 percent the aircraft is firesafe. If LEL is less than 10 percent (20 percent for foam removal) the aircraft is entry safe. Additional purging with MIL-F-38299 is not necessary, proceed to paragraph 5-4.1.2(l).
- d. Test purging fluid for solids contamination and flashpoint. Flash point shall be 121°F or higher when tested in accordance with ASTM D93. Solids contamination shall meet the requirements of TO 42B- 1-1 for JP-4 aircraft fuel. Periodically during the purge procedure the flashpoint of the fluid shall be tested. Purging shall cease any time the flash point of the fluid drops below 120°F. Use aeration or other acceptable procedures to restore the fluid to within 10 to 15 degrees of the original flashpoint.
- e. If aircraft contains explosion suppression foam test conductivity of purging fluid prior to purging. Conductivity of purging fluid shall be between 100 and 700 conductivity units (CU) prior to starting purge operation. Conductivity will degrade with each use. Monitor and ensure conductivity of fluids remains between 100 to 700 CU. Blend conductivity additive into fluid as necessary.
  - (1) Conductivity test procedure. Obtain a one pint sample of fluid to be tested. Test conductivity in accordance with TO 42B-1-1 using portable conductivity

meter. Since conductivity is temperature dependent conductivity should be tested within five minutes of obtaining sample. Record fluid temperature with each conductivity measurement.

- (2) Blending procedure for conductivity additive. Antistatic additive is available in one gallon cans. If conductivity is below 100 cu, blend three parts by volume of additive to one million parts by volume purging fluid. The additive should be diluted by adding nine parts purge fluid to one part additive. Inject the mixture below the surface level of the fluid in the tank by using a tunnel or rubber hose. Extend the hose through a hatch in the top so the end is below the surface of the purge fluid. This will eliminate the possibility of a static discharge which could be created from the free fall of the additive if it was poured through the vapor space. The additive disperses slowly in the purging fluid. Dispersion can be accelerated by adding the additive to a tank prior to receipt of new product, circulating the fluid or by aeration. If such mixing is impractical the mixture should be allowed to sit for twelve hours to allow the additive to disperse.
- f. Fluid may be stored in a fuel trailer or storage tank. Mark container to denote contents.
- g. Connect purging fluid supply to aircraft.
- h. Fill each tank. Each tank may be filled separately and transferred to any other tank or throughout the complete system. The fluid shall remain in the tank for a minimum of 10 minutes before removal or transfer.
- i. Evacuate fluid from tank.
- j. Check oxygen level in tank. If oxygen level is not between 19.5 and 23.5 percent repeat purge procedure.
- k. Check lower explosive limit. If LEL is not below 20 percent repeat purge procedure. If the tank is to be entered repeat the purge procedure until entry safe LEL and oxygen level is attained.
- l. Drain and depuddle tanks as necessary. Maintain mechanical ventilation and comply with all requirements of the entry permit during entry.

- m. For hangared aircraft the LEL shall be checked daily or more often as deemed necessary. Normally a LEL check will be made at the beginning of each shift.

#### 5-4.2 JP-5 and JP-8 Fluid Purging Procedures.

##### 5-4.2.1 Equipment and Materials Required.

Equipment to fuel and defuel, purge fluid, oil, safety containers, bowsers, oxygen analyzer, combustible vapor meter.

##### 5-4.2.2 Procedures.

- a. Defuel aircraft in accordance with applicable manual.
- b. Open sumps and drains. Drain fuel into an approved safety container.

WARNING

The LEL of a tank purged with JP-8 may not remain under 20 percent if the ambient temperature exceeds 75° F at standard atmospheric pressures. If it is expected the temperature will exceed 75° F the tank should be purged with another fluid or air purged.

- c. If aircraft was fueled with JP-5 or JP-8 check oxygen level and LEL. If oxygen level is between 19.5 and 23.5 percent, check LEL. If LEL is less than 20 percent the aircraft is firesafe. If LEL is less than 10 percent (20 percent for foam removal) the aircraft is entry safe. Additional purging is not necessary. Proceed to paragraph 5-4.2.2.m, if additional purging is not required.
- d. Test purging fluid for solids contamination and flashpoint. Flashpoint shall be 121° F or higher when tested in accordance with ASTM D93. Solids contamination shall meet the requirements of TO 42B-1-1 for JP-4 aircraft fuel. Periodically during the purge procedure the flashpoint of the fluid shall be tested. Purging shall cease any time the flash point of the fluid drops below 120°F. Use aeration or other acceptable procedures to restore the fluid to within 10 to 15 degrees of the original flashpoint. JP-5 and JP-8 may be blended with not less than four parts JP-4 to make a mixture that can then be used to service aircraft or engines that operate on JP-4. The fuel quality of the blend shall meet the requirements of TO 42B-1-1.

- e. JP-5 and JP-8 contain conductivity additives. The addition of conductivity additive should not be necessary.
- f. Fluid may be stored in a fuel trailer or storage tank. Mark container to denote contents.
- g. Connect purging fluid supply to aircraft.
- h. Fill each tank. Each tank may be filled separately or transferred to another tank. The fluid shall remain in the tank for a minimum of 10 minutes before removal or transfer.
- i. Evacuate fluid from tank.
- j. Check oxygen level in tank. If oxygen level is not between 19.5 and 23.5 percent repeat purge procedure.
- k. Check lower explosive limit. If LEL is not below 20 percent repeat purge procedure. If the tank is to be entered repeat the purge procedure until an entry safe LEL and oxygen level is attained.
- l. Drain and depuddle tanks as necessary. Maintain mechanical ventilation and comply with all requirements of the entry permit during entry.
- m. For hangared aircraft the LEL shall be checked daily or more often as deemed necessary. Normally a LEL check will be made at the beginning of each shift.

#### 5-5 AIR PURGE PROCEDURES.

##### NOTE

Combination exhaust and blow is the preferred method for air purge operations.

##### 5-5.1 Combination Exhaust and Blow Purge Procedures.

###### 5-5.1.1 Equipment and Materials Required.

Equipment to defuel aircraft, safety streamers, air blowers, air ducts, air compressor, safety containers, bowsers, oxygen analyzer, combustible vapor meter.

###### 5-5.1.2 Procedures.

- a. Defuel aircraft in accordance with applicable manual.
- b. Open sumps and drains. Drain fuel into an approved safety container.

WARNING

The LEL of a tank purged with JP-8 may not remain under 20 percent if the ambient temperature exceeds 75° F at standard atmospheric pressures. If it is expected the temperature will exceed 75° F the tank should be purged with another fluid or air purged.

- c. If aircraft was fueled with JP-5 or JP-8 check oxygen level and LEL. If oxygen level is between 19.5 and 23.5 percent, check LEL. If LEL is less than 20 percent the aircraft is firesafe. If LEL is less than 10 percent (20 percent for foam removal) the aircraft is entry safe. Proceed to paragraph 5-5.1.2.n.
- d. For open areas place the blower or HDU-13M heater convenient to the aircraft. Blower or heater shall be bonded in accordance with Section II.
- e. Attach blow purge ducts to the outlet side of the blower and extend to the aircraft.
- f. Bond the ducts to the aircraft. Bonding wire may be at the end or at the first section from the end.

CAUTION

To prevent damage to the aircraft make sure all vents and filler caps are open before starting blower.

- g. Start the blower prior to opening fuel tank access doors.
- h. Remove access doors or panels. Take care to prevent damage to doors, panels and aircraft. Tilt the door inward to avoid fuel spillage.

WARNING

To prevent possibility of fire or explosion, the blower must be turned on prior to connecting air ducts to the aircraft. If power fails, immediately remove the air duct from the aircraft and move the air duct and blower to an area free from fuel fumes. Failure

to comply with this procedure could result in injury or death to personnel and damage to or destruction of the aircraft.

- i. Install exhaust and blow ducts in opening.
- j. Purge for 30 minutes. If needed, after 15 minutes, move the duct to a different position to complete the purge.
- k. Remove exhaust duct from opening. Do not turn blower off until purge procedure is complete.
  - l. Check oxygen level in tank. If oxygen level is not between 19.5 and 23.5 percent repeat purge procedure.
- m. Check lower explosive limit. If LEL is not below 20 percent repeat purge procedure for 15 minutes. If the tank is to be entered repeat the purge procedure until an entry safe LEL and oxygen level is attained.
- n. Drain and depuddle tanks as necessary. Maintain air purge and comply with all requirements of the entry permit during entry.
- o. For hangared non-foamed aircraft the LEL shall be checked every four hours or more often as deemed necessary to assure a fire safe condition is maintained. Normally a LEL check will be made at the beginning of each shift. When working in a foam equipped aircraft the LEL shall be checked using a continuous monitoring combustible meter or checked every two minutes using a non-continuous meter. Readings will be taken at the entry point and progressively to the furthest point at which maintenance operations extend inside the tank. After all foam is removed the tank should be considered a non-foamed tank.

## 5-5.2 Exhaust Purge Procedures.

### 5-5.2.1 Equipment and Materials Required.

Equipment to defuel aircraft, safety streamers, air movers, air ducts, air compressor, safety containers, bowzers, oxygen analyzer, combustible vapor meter.

### 5-5.2.2 Procedures

- a. Defuel aircraft in accordance with applicable manual.
- b. Open sumps and drains. Drain fuel into an approved safety container.

**WARNING**

The LEL of a tank purged with JP-8 may not remain under 20 percent if the ambient temperature exceeds 75° F at standard atmospheric pressures. If it is expected the temperature will exceed 75° F the tank should be purged with another fluid or air purged.

- c. If aircraft was fueled with JP-5 or JP-8 check oxygen level and LEL. If oxygen level is between 19.5 and 23.5 percent, check LEL. If LEL is less than 20 percent the aircraft is firesafe. If LEL is less than 10 percent (20 percent for foam removal) the aircraft is entry safe. Proceed to paragraph 5-5.2.2.n.
- d. For open areas place the blower or HDU-13/M heater convenient to the aircraft. Blower or heater shall be bonded in accordance with Section II.
- e. Install air movers. Attach exhaust purge ducts to the inlet side of the blower and extend to the aircraft.
- f. Bond the ducts to the aircraft. Bonding wire may be at the end or at the first section from the end.

**CAUTION**

If necessary, to prevent damage to the aircraft, make sure all vents and filler caps are open before starting blower.

- g. Start the air mover and blower prior to opening fuel tank access doors.
- h. Remove access doors or panels. Take care to prevent damage to doors, panels and aircraft. Tilt door inward to prevent fuel spillage.

**WARNING**

To prevent possibility of fire or explosion, the blower must be turned on prior to connecting air ducts to the aircraft. If power fails, immediately remove the air duct from the aircraft and move the air duct and blower to

an area free from fuel vapors. Failure to comply with this procedure could result in injury or death to personnel and damage to or destruction of the aircraft.

- i. Install exhaust duct in opening.
- j. Purge for 30 minutes. If needed, after 15 minutes, move the duct to a different position to complete the purge.
- k. Remove exhaust duct from opening. Do not turn blower off until purge procedure is complete.
  - l. Check oxygen level in tank. If oxygen level is not between 19.5 and 23.5 percent repeat purge procedure.
- m. Check lower explosive limit. If LEL is not below 20 percent repeat purge procedure for 15 minutes. If the tank is to be entered repeat the purge procedure until an entry safe LEL and oxygen level is attained.
- n. Drain and depuddle tanks as necessary. Maintain air purge and comply with all requirements of the entry permit during entry.
- o. For hangared non-foamed aircraft the LEL shall be checked every four hours or more often as deemed necessary to assure a fire safe condition is maintained. Normally a LEL check will be made at the beginning of each shift. When working in a foam equipped aircraft the LEL shall be checked using a continuous monitoring combustible meter or checked every two minutes using a non-continuous meter. Readings will be taken at the entry point and progressively to the furthest point at which maintenance operations extend inside the tank. After all foam is removed the tank should be considered a non-foamed tank.

### 5-5.3 Blow Purge Procedures.

#### 5-5.3.1 Equipment and Materials Required.

Equipment to defuel aircraft, safety streamers, air movers, air ducts, air compressor, safety containers, bowsers, oxygen analyzer, combustible vapor meter.

#### 5-5.3.2 Procedures.

- a. Defuel aircraft in accordance with applicable manual.
- b. Open sumps and drains. Drain fuel into an approved safety container.

**WARNING**

The LEL of a tank purged with JP-8 may not remain under 20 percent if the ambient temperature exceeds 75° F at standard atmospheric pressures. If it is expected the temperature will exceed 75° F the tank should be purged with another fluid or air purged.

- c. If aircraft was fueled with JP-5 or JP-8 check oxygen level and LEL. If oxygen level is between 19.5 and 23.5 percent, check LEL. If LEL is less than 20 percent the aircraft is firesafe. If LEL is less than 10 percent (20 percent of foam removal) the aircraft is entry safe. Proceed to paragraph 5-5.3.2.n.
- d. For open areas place the blower or HDU-13/M heater convenient to the aircraft. Blower and heaters shall be bonded in accordance with Section II.
- e. Attach blow purge ducts to the outlet side of the blower.
- f. Start the air mover and blower prior to opening fuel tank access doors (if used).
- g. Bond the ducts to the aircraft. Bonding wire may be at the end or at the first section from the end.
- h. Remove access doors. Take care to prevent damage to door and aircraft. Tilt the door as necessary to prevent fuel spillage.

**WARNING**

To prevent possibility of fire or explosion, the blower must be turned on prior to connecting air ducts to the aircraft. If power fails, immediately remove the air duct from the aircraft and move the air duct and blower to an area free from fuel vapors. Failure to comply with this procedure could result in injury or death to personnel and damage to or destruction of the aircraft.

- i. Install blower duct in door opening.
- j. Purge for 30 minutes.

- k. Remove blower duct from opening. Do not turn blower off until purge procedure is complete.
- l. Check oxygen level in tank. If oxygen level is not between 19.5 and 23.5 percent repeat purge procedure.
- m. Check lower explosive limit. If LEL is not below 20 percent repeat purge procedure for 15 minutes. If the tank is to be entered repeat the purge procedure until an entry safe LEL is attained.
- n. Drain and depuddle tanks as necessary. Maintain blow purge and comply with all requirements of the entry permit during entry.
- o. For hangared non foamed aircraft the LEL shall be checked every four hours or more often as deemed necessary to assure a fire safe condition is maintained. Normally a LEL check will be made at the beginning of each shift. When working in a foam equipped aircraft the LEL shall be checked using a continuous monitoring combustible meter or checked every two minutes using a non-continuous meter. Readings will be taken at the entry point and progressively to the furthest point at which maintenance operations extend inside the tank. After all foam is removed the tank should be considered a non-foamed tank.

#### 5-6 VENTILATION PROCEDURES. (FLUID PURGE ONLY).

5-6.1 Ventilation is used to provide fresh air to the entrant. Tanks requiring an air supply to maintain or lower the LEL or chemical concentrations shall be considered air purged. Tanks can be ventilated using the same equipment and connections as required for an air purge or any locally approved procedure.

5-6.2 When applying ventilation to a tank:

5-6.2.1 Check the LEL once per shift or more often as deemed necessary.

5-6.2.2 Ensure no fuel is brought into the tank. Solvents, sealants, adhesives or other chemicals are permitted in quantities which will not cause the generation of a hazardous atmosphere. If these items are brought into the tank in quantities which can generate a hazardous atmosphere, initiate air purge procedures.

#### 5-7 EXPLOSION SUPPRESSION FOAM MATERIALS (FUEL FOAM).

5-7.1 GENERAL. The Air Force uses foam materials specification MIL-B-83054 and MIL-F-87260. Fuel foam materials: suppress explosive reactions; control ignition rate of burning fuel vapors; and act as a baffle to limit fuel sloshing. Fuel tanks containing fuel foam will not explode when pierced by ground fire or when subjected to electrical arcs from failed components or as the result of lightning.

5-7.2 MIL-B-83054 FUEL FOAM MATERIAL. Foam meeting specification MIL-B-83054, is generally referred to by type or color and include the following: Type I (orange), Type II (yellow), Type III (red), Type IV (dark blue), and Type V (light blue). Types I, II, and III are susceptible to deterioration from exposure to high temperature, humidity and have a service life of from two to seven years. Types IV and V have better resistance to temperature, humidity and have a longer service life. MIL-B-83054 foam materials are not electrically conductive and can develop an electrical potential during certain fuel servicing operations or flight profiles. These static charges can discharge and cause singeing or burning. Types IV and V have a higher volume swell and lower tensile strength and tear resistance, therefore, it is important that these types be carefully sized and properly installed with adequate clearances. Type I, II and IV are coarse pore foams. Types III, and V are fine pore foams. Fine and coarse pore foams are not interchangeable.

5-7.3 MIL-F-87260 FUEL FOAM MATERIAL. Foam meeting specification MIL-F-87260 may be any color except orange, yellow, red, or blue. Generally the foam material is grey or black in color. Foam materials meeting specification MIL-F-87260 are electrically conductive and will not hold a static electricity charge. The foam is separated into two classes, each containing two grades of foam. Class 1 foam has a temperature range of 0°F to + 160°F, Class 2 material has a temperature range of -30° F to +160°F. Grade IC foam is coarse pore material. Grade IIC foam is a fine pore material. Fine and coarse pore foams are not interchangeable. These foams have some tolerance to humidity.

#### 5-7.4 FOAM REMOVAL PROCEDURES.

5-7.4.1 Requirements for open tank maintenance and in-tank maintenance apply as necessary.

5-7.4.2 Defuel aircraft as necessary.

5-7.4.3 Drain sumps and drains as necessary.

5-7.4.4 Purge and enter tanks, as necessary.

5-7.4.5 Slowly remove foam to minimize static electricity buildup. Use care to prevent tearing

foam. Remove only the foam necessary to accomplish the inspection/repair.

5-7.4.6 Depuddle as necessary.

5-7.5 FOAM INSPECTION CRITERIA. After removal and before storage foam shall be inspected for the following:

5-7.5.1 Legibility of Marking.

5-7.5.2 If markings are not legible, identify and use a fuel resistant marker to mark with proper alphanumeric combination in accordance with the aircraft technical order.

5-7.5.3 Cleanliness or Contamination. Examine for foreign particles such as lint or fibers. Remove contamination either by hand or with an approved vacuum cleaner. Replace excessively contaminated foam or foam which cannot be cleaned. Foam in low areas of tank will have a tendency to collect higher concentrations of foreign particles.

5-7.5.4 Burning or Singeing. Examine for burning or singeing. Replace damaged foam. Normal indication of damage are surface color changes, formation of rough bead-like surface, excessive gorging in foam pattern or areas of stickiness. The most likely areas to find evidence of burned or singed foam are tank vent outlets and inlets.

5-7.5.5 Deterioration. Examine foam for loose particles or pull on a few foam strands, if foam has loose particles or strands tear easily, replace foam. The most likely areas to find deterioration are in the upper areas near the vents.

5-7.5.6 Tears or Punctures. Examine for tears or punctures, excessively damaged foam shall be replaced.

#### 5-7.6 REPLACEMENT FOAM.

5-7.7 INSTALLATION/REINSTALLATION OF FOAM. Proper installation/ reinstallation of foam is extremely important. Voids designed into the foam provide clearances around fuel systems components such as vents, pumps, probes and interconnects. After reinstallation or replacement of foam around a component, interconnect or vent, accomplish functional testing of the fuel system. The testing will include all safety of flight items and may be performed during the fuel and defuel (flushing) contamination test. Flushing shall be accomplished in accordance with the weapon system manuals. If the weapons system manuals do not provide guidance for flushing the following will be used.

5-7.7.1 Large Aircraft. If 25 percent (by volume) or more of the foam has been removed from any one tank and reinstalled or replaced the tank must

be flushed with clean filtered fuel to remove contamination.

5-7.7.2 Medium or Small Aircraft (Example: F-15). If 25 percent (by volume) or more of the foam has been removed/reinstalled or replaced from an aircraft, the aircraft must be flushed with clean filtered fuel to remove contamination.

#### NOTE

Refer to TA 012 for definition of small, medium, and large frame aircraft and aircraft listings.

5-7.7.3 Fuel System Flushing. A minimum of one fuel and defuel shall be accomplished in accordance with TO 42B-1-1. Acceptable increase in solids contamination is 2 mg/gal over that serviced to the aircraft during fueling. Emphasis should be placed on draining tank sumps and on periodic checking of fuel strainers.

### 5-8 DEPUDDLING.

5-8.1 GENERAL. Depuddling is the removal of residual fuel or purge fluid which remain after the tanks are drained. Depuddling may be accomplished by using absorbent cloths, sponges, mops and approved safety container or an approved air operated vacuum. All fuel puddles in the path of air flow or where work will be accomplished will be removed.

5-8.2 Equipment and Materials Required. Equipment to defuel aircraft, sponges, absorbent cloths, safety container, mop, equipment to purge aircraft, air operated vacuum cleaner.

#### 5-8.3 Depuddling Procedures.

5-8.3.1 Requirements for open tank maintenance and in-tank maintenance apply as necessary.

5-8.3.2 Defuel aircraft fuel tanks as necessary.

5-8.3.3 Drain sumps and drains as necessary.

5-8.3.4 Purge and enter tanks as necessary.

5-8.3.5 Remove fuel foam as necessary.

5-8.3.6 Use cloth, sponge, mop, and approved safety container or air operated vacuum to remove fuel puddles.

### 5-9 INERTING.

5-9.1 GENERAL. Inerting is the replacement of oxygen in air or air-fuel mixture with an inert gas to the point that the oxygen content is too low to support combustion. Nitrogen is the gas most commonly used to inert AF aircraft fuel tanks. Carbon dioxide can be used but is not preferred due to its high solubility in fuel. Inerting may be used to safeguard a tank during hot work. Inerting

may also be used to safeguard adjacent tanks. The two approved methods of inerting are pressure inerting and siphon inerting.

### 5-9.2 REQUIREMENTS.

5-9.2.1 Measurement of Gas Concentration. The concentration of inert gas is not a direct measurement of inerting gas, but it is measured as a percentage of oxygen remaining in the atmosphere. An approved oxygen analyzer shall be used to measure the oxygen content of the atmosphere in the tank.

5-9.2.2 Inert Gas Concentration. The oxygen content of a tank shall be maintained at nine percent or less for siphon inerting and four percent or less for pressure inerting. Once a tank is inerted it shall remain inerted until repairs are complete. A positive inert gas pressure should be maintained on the inerted tank.

5-9.2.3 Certifying Inerted Tanks. Inerted tanks shall be certified by a qualified fuel system repairer. For tanks in work, tanks shall be retested at the start of every shift, periodic intervals not to exceed four hours or more often as deemed necessary. For tanks on aircraft not in work the tank shall be retreated daily. Periodic checks shall be accomplished to ensure an inert atmosphere is maintained. Special consideration shall be given to retesting and assuring the inert atmosphere in nonmetallic fuel cells.

### 5-10 SIPHON INERTING.

5-10.1 GENERAL. Siphon inerting is when an aircraft fuel tank is filled to capacity with fuel and then drained with an inert gas siphoned into the tank void spaces. Siphon inerting is considered the most efficient procedure for inerting interconnected tanks in that this procedure assures an even distribution of inert gases throughout a fuel tank system.

5-10.2 Equipment and Materials Required: Inert gas supply, surge tank, differential pressure gauge, tubing, oxygen analyzer, equipment to defuel aircraft, safety streamers, fuel servicing truck.

5-10.3 Siphon Inerting Procedures. Assemble equipment as shown in figure 5-3.

5-10.3.1 Fill aircraft to capacity with fuel.

5-10.3.2 Open pressure valve, set gas pressure to between 1 and 1 1/2 pounds/inch<sup>2</sup>.

5-10.3.3 Open gas needle valve to allow gas to inert surge tank and connecting lines.

5-10.3.4 Conduct a static pressure test to ensure integrity of system.

5-10.3.5 Connect inert gas line to fuel vent opening. Ensure connection is air tight.

provide a continuous supply of gas and prevent collapse of tank.

5-10.3.6 Defuel aircraft while opening needle gas to inert gas line. Line shall be opened enough to



5-10.3.7 Maintain positive pressure between 1 and 1 1/2 pounds/inch<sup>2</sup>. Ensure maximum safe working pressure is not exceeded.

5-10.3.8 After drain is complete it is preferred that equipment remain installed and a slight positive pressure be maintained. Nitrogen quantity shall be renewed as necessary. If inert gas supply is depleted the tank shall be considered un-inert and the oxygen content shall be determined. Reac-complish inerting procedures if necessary. The inert gas supply line may be disconnected at the surge tank inlet and capped off. If this is done oxygen content must be monitored to insure tank does not become un-inert due to thermal contraction.

#### 5-11 PRESSURE INERTING.

5-11.1 GENERAL. Pressure inerting is the process of placing an inert gas under pressure into the vapor space of a fuel tank. Pressure inerting works best on single tanks whether integral, mounted on, or removed from an aircraft. Pressure inerted tanks shall be thoroughly tested to ensure the entire vapor space is sufficiently inert.

5-11.2 Equipment and Materials Required: Inert gas supply, pressure regulator, needle-type control valve, tubing with bonding wire, pressure relief valve, gas tight fitting for filler neck, safety streamer, oxygen analyzer.

5-11.3 Pressure Inerting Procedures. Assemble equipment as shown in figure 5-2.

5-11.3.1 Install gas tight fitting on tubing.

5-11.3.2 Ensure bond wire has continuity from gas source to fitting.

5-11.3.3 Ground pressure inerting equipment.

5-11.3.4 Clear moisture and dust from inert gas delivery system by discharging a small amount of gas.

5-11.3.5 Connect bond wire from inert gas delivery system to aircraft or tank.

5-11.3.6 Connect gas tight fitting to fuel tank filler assembly. Ensure integrity of gas tight seal.

5-11.3.7 Adjust inert gas pressure regulator to proper level.

5-11.3.8 Open needle valve. Check pressure relief valve. If gas is discharging, reduce needle valve opening until discharge stops.

5-11.3.9 Continue flow until inert atmosphere is obtained. Thoroughly probe all areas of tank to ensure tank is inert.

5-11.3.10 Close off vent line openings with gas tight plug or seal.

5-11.3.11 Remove gas tight fitting from fuel tank opening and cover with safety seal or leave equipment in place.

5-11.3.12 Tank shall remain inerted until repairs are complete.

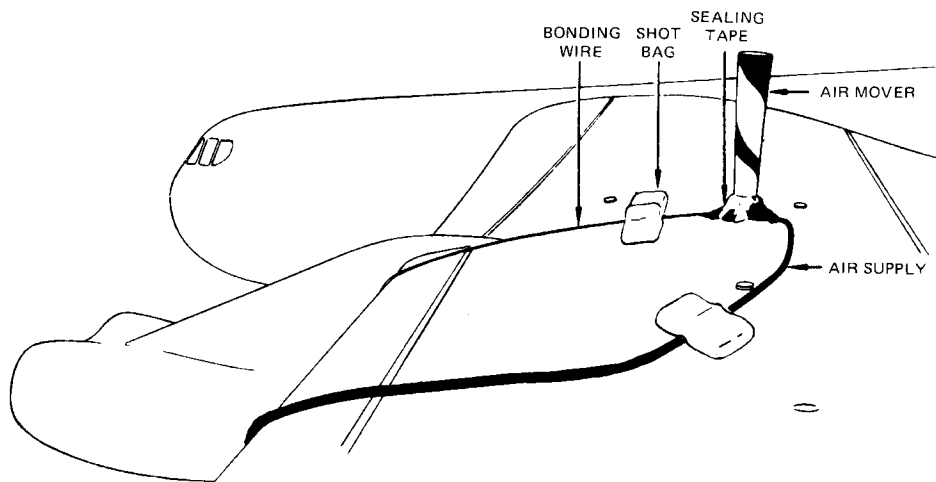


Figure 5-1. Air Mover Installation

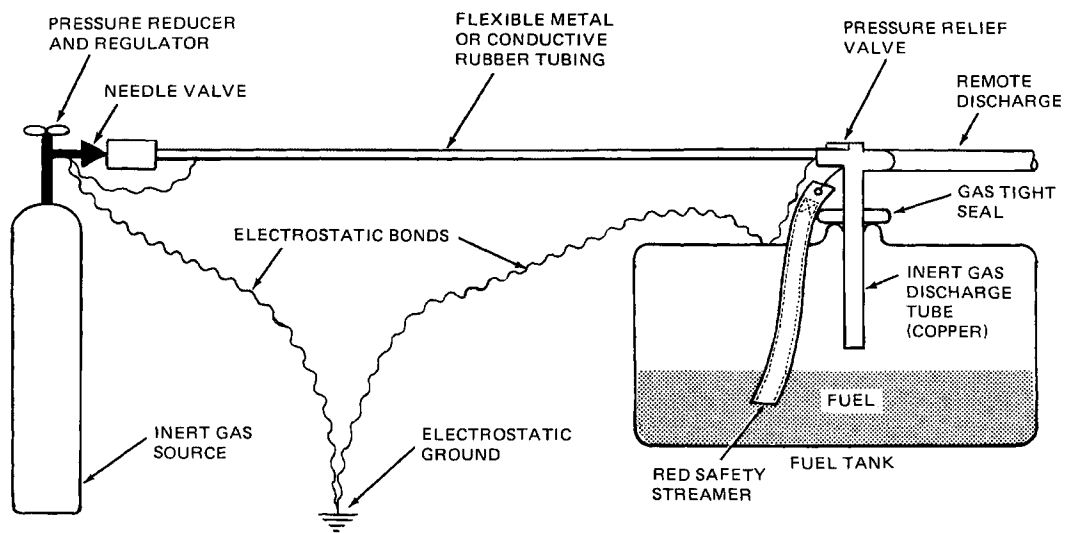


Figure 5-2. Schematic Diagram of Pressure Inerting

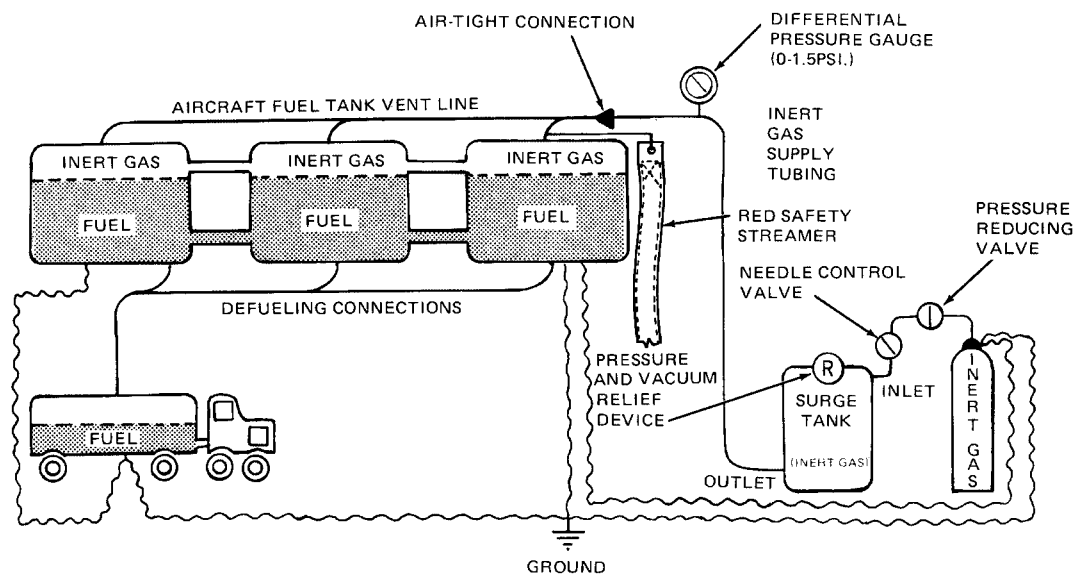


Figure 5-3. Schematic Diagram of Siphon Inerting



## SECTION VI

### INTEGRAL TANKS

#### 6-1 PURPOSE.

This section provides additional information on locating fuel leaks and applying permanent repairs to fuel leaks occurring in integral tanks.

#### 6-2 GENERAL.

6-2.1 Integral tanks were developed because they offered the capability of greater fuel containment with a decrease in weight over fuel cell type construction. The tanks are designed with a seal plane, which has been sealed with gaskets, structural adhesives, elastic films or other sealants. Integral tanks have been built into both the wing and fuselage sections of an aircraft with the primary structure forming the boundaries of the tank.

6-2.2 The leak detection methods described in this section are more involved than the methods described in Section IV. The methods described in this section should be used prior to initiating permanent repairs.

6-2.3 ALC maintenance activities should consult the aircraft documents and remove all temporary repairs, external fastener repairs, and repair the aircraft in accordance with this section or aircraft specific weapon system manuals.

#### 6-3 FUEL LEAKS.

6-3.1 LEAK PATH ANALYSIS. Planning is extremely important in locating fuel leak paths. The procedures for locating fuel leaks shall be closely followed. The following sequence should be used to locate leaks:

6-3.1.1 Determine the exact exit points using one of the approved methods (of this manual).

6-3.1.2 Isolate leak to proper tank.

6-3.1.3 Using aircraft technical manuals, analyze leak paths.

6-3.1.4 Using approved methods (of this manual) determine leak source.

6-3.2 DETERMINING WHICH TANK IS LEAKING. Fuel leaks which appear near the common boundary of two adjacent tanks may originate in either tank. One method to isolate the leaking tank is to use the following procedures:

6-3.2.1 Transfer/defuel one of the tanks normally the lowest tank.

6-3.2.2 Allow time for fuel to drain and check for leak. If leak has stopped the tank which just had the fuel removed was the leaking tank.

6-3.2.3 If tank is still leaking transfer fuel to other tank.

6-3.2.4 Allow time for fuel to drain. If leak has stopped the tank which just had the fuel removed was the leaking tank.

6-3.2.5 If leak continues either both tanks are leaking or residual fuel is giving the indication. If residual fuel is suspected perform the following.

6-3.2.6 Transfer/defuel both tanks and drain residual fuel.

6-3.2.7 Fuel one tank, if no indication appears, the other tank is the leaker. If leak is indicated, continue.

6-3.2.8 Transfer/defuel the fueled tank, wait for leak to stop, then fuel the other tank. If a leak is indicated, both tanks leak.

#### 6-4 LEAK EXIT POINT DETECTION.

##### 6-4.1 PRESSURE TEST.

6-4.1.1 GENERAL. If previous efforts to locate a leak exit point have been unsuccessful, or other methods to locate a leak appear impractical, a pressure test may be used to locate leak exit points. A pressure test is effective in locating leaks which appear only under stress, in-flight leaks, confirming repair work prior to refueling, or when a tank has multiple leaks. The pressure test requires extensive preparation. Extreme care must be taken during the preparation and execution of the test to prevent damaging the aircraft. Particular attention must be given to the aircraft vent systems and specified pressure limits of the applicable tank. A water manometer shall be used as a pressure limiting device. Pressurization and depressurization shall be accomplished in accordance with weapon system manuals. Generally pressurization and depressurization should occur slowly (approximately 15 minutes/cycle) to avoid structural damage to the aircraft. In addition to entries on the AFTO Form 781A, a checklist shall be developed to ensure all plugs, cover plates, and caps are removed. These procedures require two personnel, one shall be stationed at the tank access adapter and shall monitor the manometer, and the other shall locate and mark leak exit points.

#### 6-4.1.2 Materials and Equipment Required.

Water manometer, access door adapter (with manual shutoff valve, positive and negative pressure relief valves), caps, cover plates, plugs, safety streamers, equipment to defuel and purge tanks, air supply, non-corrosive leak detection compound, marking pencil, solvent or aircraft cleaning compound and water.

6-4.1.3 Procedures. Refer to the aircraft technical manuals for specific guidance. General procedures are as follows:

- a. Defuel and purge tanks as necessary.
- b. Install plates, caps, and plugs as required to all fittings. Ensure cables are attached to door cover.
- c. Attach air supply to access adapter door manual shut off valves.
- d. Pressurize tank to maximum allowable air pressure (refer to specific aircraft TOs). Additional pressure will not aid in leak detection.
- e. Apply leak detection compound to tank exterior. Spread the leak detection compound with a brush. Observe tank for formation of bubbles.
- f. Mark leak exit points.
- g. Within 24 hours wash leak detection compound from aircraft.

6-4.2 DEVELOPMENT OF LEAK PATH ANALYSIS. Develop a leak path analysis for each leak exit point. Thoroughly analyze the area and structure around the leak exit point for all possible leak paths and sources. When investigating the location and cause of a fuel leak in the fuel tank boundary structure, keep in mind the fuel leak may be caused by a structural failure. Fuel can leak through an almost invisible crack in the structure. When a leak occurs, structural failure should be considered as a possible cause.

6-4.3 INSPECTION OF TANK INTERIOR. A thorough investigation of the area surrounding the leak exit can help isolate the leak source. Study the structure in the leak area and the direction from which the leak seems to be flowing. Visible defects in the sealant or structure are not necessarily the leak source. Structural failures shall not be repaired by applying sealant to the failed area. An inspection checklist may be helpful. The following are common items to check when performing a visual inspection of the tank interior.

6-4.3.1 Inspect for loose, cracked or missing fasteners.

6-4.3.2 Inspect for defective sealant such as:

- a. Previously repaired areas.
- b. Cracks, scuffs, or nicks.
- c. Indications of air bubbles or shrinkage.
- d. Lack of adhesion by applying air pressure. Air pressure shall be a maximum 100 psi. Hold the nozzle approximately one inch from sealant.
- e. Loss of luster, discoloration, chalking or loss of topcoat.
- f. Loss of elasticity by firmly pressing sealant with a blunt metal punch (not less than 3/16 inch diameter). The sealant is good if it gives and returns to original position. The sealant is defective if the sealant breaks or does not return to original position.

### 6-5 LEAK SOURCE DETECTION.

#### 6-5.1 GENERAL.

6-5.1.1 There are several methods to locate leak sources, using either pressure or vacuum sources. The pressure methods are blow back method, pressure box method, dye injection method. Blow back and pressure box and the vacuum method incorporate the use of a non-corrosive leak detection fluid (bubble solution).

6-5.1.2 Planning is essential to locating leak sources. Locate all leak sources prior to initiating repairs.

6-5.1.3 Methods to locate leak sources are detailed in order of ease and time required, starting with the easiest and least time consuming.

#### 6-5.2 BLOW BACK METHOD.

6-5.2.1 GENERAL. The blow back method requires access to the tank interior. This method requires at least two personnel. One will blow air on the tank exterior, the other will apply leak detection fluid to the inside of the tank and observe for leaks.

6-5.2.2 Equipment and Materials Required. Air supply, nozzle, non-corrosive leak detection compound, equipment to defuel, drain, depuddle and purge aircraft, lint free cloth, brush.

#### 6-5.2.3 Procedures.

- a. Position one repairer in the tank and the other outside the tank.
- b. One repairer shall apply leak detection fluid to the tank.
- c. The other repairer shall apply air pressure, from 1 to 100 psi (100 psi maximum), to

■ the suspected leak point area. Keep nozzle approximately one half (1/2) inch from surface.

- d. When bubbles are detected mark both where the air was applied and where the



bubbles formed. Small leaks may require the use of a pressure box.

- e. Recheck by applying air pressure to the points where the leak detection fluid bubbled and applying leak detection fluid to place where air was previously applied.
- f. Verify marks.
- g. Leak detection powder may be substituted for non-corrosive leak detection fluid. If the powder is used: ensure the area is dry; the powder is used sparingly; and the area is cleaned of all powder residue.

### 6-5.3 PRESSURE BOX METHOD.

6-5.3.1 GENERAL. This method works by pressurizing a large exterior surface area which in turn forces air back through the leak path in to the tank. The pressure box may be flat or contoured. This method is useful in locating seep type leaks.

6-5.3.2 Materials and Equipment Required. Control box, zinc chromate putty, pressure box, air supply, air hose, end plates, air strut, shot bags, non-corrosive leak detection compound, marking pencil, equipment to defuel, drain, depuddle and purge tanks.

#### 6-5.3.3 Procedures.

- a. Install appropriate end plates for covering structure at external leak point.
- b. Mount pressure box over leak exit point. For lower surfaces support with air strut. The air strut should have at least 10 inches of free piston travel to allow for changes in wing position. For upper surfaces hold in place with shot bags.
- c. Connect pressure box to control box and pressurize to four psi or as specified by the aircraft technical manuals.
- d. Apply air to air strut, 100 psi (or to a pressure equivalent force) or as specified in aircraft technical manuals.
- e. Apply leak detection compound to suspected leak areas. Observe for bubbles.
- f. Mark all leaks.

### 6-5.4 DYE INJECTION METHODS.

6-5.4.1 GENERAL. This method requires a small amount of dyed fuel be injected through the leak exit point. The dye may be a colored dye, which leaves a colored stain, or a fluorescent dye which is visible with the aid of an ultraviolet light (black light).

#### 6-5.4.2 Materials and Equipment Required.

Control box, two dye injecting devices (double cup or hollow bolt), vacuum cup, zinc chromate putty, pressure box, vacuum pump, air supply, vacuum hose, air hose, air strut, shot bags, dye solution, ultraviolet light, marking pencil, jet fuel, equipment to defuel, drain, depuddle and purge tanks.

#### 6-5.4.3 Procedures.

- a. Using Double Cup Assembly. The double cup assembly is used to locate leak sources by forcing dye solution through the leak exit point mix dye, one part fluorescent dye to ten parts fuel or one ounce colored dye to 100 gallons fuel, and fill control box reservoir.
  - (1) Connect control box to double cup assembly. The hose from the outer segment connects to the vacuum source and the inner segment connects to the pressure dye source.
  - (2) Attach the double cup assembly over the leak exit point. Use zinc chromate putty, as required to ensure there are no leaks.
  - (3) Apply four psi air pressure, or pressure specified by the aircraft technical manuals to the dyed-fuel pressure tank. Bleed air from the dyed-fuel air pressure tank by opening the clamp on the double cup assembly until dyed-fuel is ejected, close clamp.
  - (4) Check for dyed fuel vapor ejection from air ejector. Any dyed fuel leaking from the cup will be sucked down the outer segment hose and blown out of the air ejector. No leakage is permitted.
- b. Using the Hollow Bolt. This method forces dye between faying surfaces. The hollow bolt method should only be used when the double cup assembly method could not identify the leak source.
  - (1) Mix dye, one part fluorescent dye to ten parts fuel or one ounce colored dye to 100 gallons fuel, and fill control box reservoir.
  - (2) Remove leaking fastener or fastener near leak and insert hollow bolt.
  - (3) Connect control box to hollow bolt with a hose to the pressure dye source of the control box.
  - (4) Apply four psi air pressure, or pressure specified by the aircraft technical

- manuals to the dyed-fuel pressure tank. Bleed air from the dyed-bolt until dyed fuel is ejected, close clamp.
- (5) Enter tank and observe for indication of dye.
  - (6) Continue pressure application as long as required to allow dyed fuel to travel the leak path. This may require 24 or more hours.
  - (7) When the dye appears mark the leak sources and close flow valve.
- c. Use of the Vacuum Cup. The vacuum cup may be used to confirm repairs or to identify a leak exit point by pulling air, dyed fuel or bubble solution through the tank structure and into a plastic container.
- (1) Connect vacuum cup to vacuum source on control box. Use zinc chromate putty, as required to ensure there are no leaks.
  - (2) Attach vacuum cup to the surface over the suspected leak.
  - (3) Apply vacuum. Wet inside of tank with dyed fuel.
  - (4) Observe transparent glass for dyed fuel. Allow sufficient time for fuel to travel length of leak path.
  - (5) When leak appears mark leak exit point, close valve.
- d. Use of Pressure Box with Dyed Fuel. This method works by pressurizing a large exterior surface area which in turn forces air back through the leak path into the tank. The pressure box may be flat or contoured. This method is useful in locating seep type leaks.
- (1) Fill pressure box with dyed fuel. To reduce the amount of fuel required, a plastic sheet supporting a quantity of dyed fuel may be taped to the lower wing surface with the pressure in the box mounted on top of the sheet.
  - (2) Pressurize the box to force the dye back along the leak path with dye solution in the control box. Bleed air through one of the screws near the top of the pressure box.
  - (3) To use less dye, tape a sheet of plastic material the same size as the pressure box over the external leak point with double sided tape.
  - (4) Tape the flat nozzle of the dye injector bottle through the plastic material.
  - (5) Mount pressure box over plastic sheet, make sure box seal bears on the plastic. For lower surfaces support with air strut. The air strut should have at least 10 inches of free piston travel to allow for changes in wing position. For upper surfaces hold in place with shot bags. Use zinc chromate putty, as required to ensure there are no leaks.
  - (6) Remove injection bottle from nozzle and loosen tube clamp so to bleed all air from plastic sheet.
  - (7) Apply approximately four psi air pressure to pressure box from the control box to force all air from inside the plastic sheet.
  - (8) Close tube clamp on injection bottle nozzle. Mount dyed fuel bottle to nozzle.
  - (9) Release pressure from pressure box, open injection bottle nozzle tube clamp, and inject dyed fuel in plastic sheet area.
  - (10) Close injection bottle nozzle and apply four psi air pressure to pressure box using control box.
  - (11) Observe tank interior for dyed fuel.
  - (12) Mark all leaks.

#### 6-5.5 VACUUM DYE METHOD.

6-5.5.1 GENERAL. The vacuum dye method is used to identify leak sources in integral tanks. A negative or vacuum pressure is applied to the tank. This method pulls dyed fuel through the leak path into the tank. The dye may be either red or fluorescent.

6-5.5.2 Materials and Equipment required. Water manometer, caps, cover plates, plugs, streamers, vacuum source, vacuum hose, dye solution, jet fuel, ultraviolet light, putty, tape, plastic bags, test door with vacuum relief, camel hair brush, syringe, marking pencil equipment to defuel, drain, depuddle and purge tanks.

#### 6-5.5.3 Procedures.

- a. Prepare tank for evacuation test in accordance with aircraft technical manuals.

- b. Check manometer reservoir for proper fluid level. Only manometers with a mixture of 50 percent water and 50 percent ethylene glycol shall be used.
- c. Ensure pressure connection is free of obstruction.



- d. Tank test fitting shall be equipped with a vacuum relief valve.
- e. All equipment taken into tank shall be inventoried.
- f. All cover plates, caps, and plugs shall be attached to the test door.
- g. Ensure the diameter of the water manometer hose is equal to or larger than the fuel tank line used for water manometer connection.
- h. Connect manometer to tank test fitting.
- i. Mix dye, one part fluorescent dye to ten parts fuel or one ounce colored dye to 100 gallons fuel. Refer to TO 42B- 1-1-10 for additional information on using dye to detect leaks.
- j. Apply vacuum pressure to tank as required by aircraft technical manuals.
- k. With brush or syringe apply dye to leak exit point. On lower wing surfaces it may be necessary to tape a bag full of dye to the surface to keep the area covered. On upper surfaces a dam may be constructed around the leak exit point with putty to keep the area wet. Keep area wet for approximately two hours, longer for small leaks.
- l. Relieve pressure.
- m. Enter tank and observe for leaks.
- n. Mark all leak sources.

## 6-6 SEALING REQUIREMENTS.

### 6-6.1 GENERAL.

6-6.1.1 This manual will detail only those sealing procedures which do not require extraordinary personnel protective equipment, separate facilities or extended cure times.

6-6.1.2 All integral tanks are similar in design in that all fuel containing surfaces of the wing or fuselage must be sealed fuel tight. The three main areas which require sealing are the tank boundaries, the access doors, and fasteners.

### 6-6.2 ACCESS DOOR SEALING METHODS.

6-6.2.1 Integral fuel tank access doors come in many shapes and sizes, but there are two basic types: plug and direct-seal. All access doors are sealed with a static seal of which there are five main configurations: flat gasket, O-ring, molded in place, bonded in place, and formed in place.

6-6.2.2 Plug Doors. This door opens into the fuel tank, and because of the design, the fuel pressure

tends to press the door outward, which provides a tighter seal.

6-6.2.3 Direct Seal Doors. This door opens to the outside of the fuel tank, and fuel pressure tends to push on the door, which increases loading on the door fasteners. The door fasteners provide the clamping force to seal the door.

6-6.2.4 Flat Gasket Seal. This is the oldest method of tank access door sealing. It is simple to local manufacture and install but may wrinkle easily or require retightening to provide a fuel tight seal. They require flat mating surfaces.

6-6.2.5 O-Ring Seals. This method requires a matching groove be machined in the access door and mating surface. When properly installed they exhibit no leakage and are generally maintenance free. Disadvantages are: the O-ring can be installed in the wrong position; O-rings are hard to install around corners; and generally O-rings are not reusable.

6-6.2.6 Molded-In-Place Seals. This method has the seal molded into the access door during manufacture. They generally provide a good seal and are reusable. They cost more, and when the seal fails the whole door must be replaced. Access door sealant may be used to repair minor nicks and cuts in the door seal.

6-6.2.7 Bonded-In-Place Seals. These seals are the same as molded-in-place with the exception that these seals can be removed and a new seal bonded in place of the damaged seal.

6-6.2.8 Formed-In-Place Seals. This seal is established by application of sealant, with a parting agent in the door-to-frame mating surface. The door is installed prior to cure of the sealant. Removal of the door frequently destroys the seal. The old sealant must be removed, surfaces cleaned and new sealant applied.

6-6.3 FASTENER SEALING METHODS. For detailed information on structural fuel tank fastener methods, refer to the aircraft technical manuals and TO 1-1A-8. The fasteners used in fuel tanks can be divided into two major types: non-self sealing and self sealing.

6-6.3.1 Non-Self Sealing Fasteners. This type of fastener cannot be installed in a hole and expected to be fuel tight. Examples of non-self sealing fasteners are access door screws or attach bolts which slip into the holes with little or no interference. They are usually sealed by one or more of the following methods: dome nuts, sealing washers and O-rings, fastener overcoat, fillet, machine fitting, and sealant grooves.

6-6.3.2 Self Sealing Fasteners. This type of fastener seals the hole by either swelling when installed, as in the case of rivets, or by interference fit, which is forcing the fastener against the sides of the hole by a few thousandths of an inch.

#### 6-6.4 TANK BOUNDARY SEALING METHODS.

##### 6-6.4.1 CURING TYPE SEALING METHODS.

Curing type sealing methods are used on all types of aircraft. Curing type sealants normally flow during application and cure with time. The sealant remains flexible, which allows it to adhere as the aircraft structure flexes. Curing type sealants may be injected into fittings, grooves, and corners; prepacked during initial assembly; applied between faying surfaces; used to overcoat fasteners and small parts; applied as a fillet to seams, butt joints etc; sprayed over fasteners, butt joints etc.; or drawn through fastener voids under vacuum pressure. Tank access is normally required to apply curing type sealants. Repair of failed sealant is time consuming and adequate scheduling of repair time and facilities is necessary. Leaks generally require removal and replacement of defective sealant.

6-6.4.2 NON-CURING TYPE SEALING METHODS. Non-curing sealants are used on many MDS aircraft but their use is generally limited to areas where access is difficult or impossible. The sealant does not cure with time or temperature. Channels or grooves are machined into the surfaces in the tank boulder and the sealant is injected into grooves through injection ports. The injected sealant adheres to the groove and is packed between structural members to form a fuel tight seal. If the sealant develops a void, fuel will leak. To repair the leak usually at least two injection port screws are removed, one, or two, on each side of the leak path. Leaks through the faying surface are repaired from the outside by injection of new sealant into the groove. The new sealant pushes the old sealant out and fills the void. The grooves may be located between rows of fasteners, zig-zagged within the fasteners, or to one side of fasteners. Injection holes are spaced at regular intervals, usually three to six inches apart and are plugged with flush screws. Proper attention must be given to assembly detail to determine which fastener is leaking and how the fastener must be sealed to prevent an inadvertent leak path.

6-6.4.3 STRUCTURAL ADHESIVE SEALING METHODS. Structural adhesive for fuel tank sealing has been used on a few aircraft. This method uses an unusually flexible structural adhesive to bond the structure together and seal the faying surfaces. Since the adhesive is flexible

the fasteners carry most of the structural loading. The adhesive requires heat to cure. If a leak develops between faying surfaces they are repaired with curing type sealant fillets or overcoats.

#### 6-7 SEALANTS.

6-7.1 GENERAL. Sealants used for permanent repairs are either curing or non-curing type. Structural adhesives are used during the manufacturing process and are not generally considered a viable repair method. Sealants used to repair aircraft require proper storage, packing, mixing, application, and inspections.

##### 6-7.2 STORAGE OF SEALANTS.

###### 6-7.2.1 UNMIXED SEALANTS.

- a. Unmixed sealants shall be stored in accordance with the manufacturer's instructions. If manufacturer's instructions are not available the following general requirements shall apply.
- b. Unmixed sealants shall not be stored at temperatures above 80° F. Higher temperatures reduce storage duration.
- c. Prior to expiration of the shelf life sealants shall be examined and tested for shelf life extension. Refer to AFM 67-1, VOL 7, PART 3, for information on the Air Force shelf life program.

###### 6-7.2.2 MIXED SEALANTS.

- a. Freezing. Some multiple part sealants may be premixed and frozen for use at a later time. Manufacturer's instructions should provide guidance as to whether a product can be premixed and frozen. Due to its low temperature cure property, PR 1826 and PR 1828 cannot be premixed and frozen for later use. Mixed sealant shall be placed in a clean, air tight cartridge that has both ends capped. A container of dry ice and isobutyl or isopropyl alcohol may be used to quick freeze the sealant. A temperature of minus 100° F shall be maintained in the container. The cartridge shall be immersed nozzle end first to a depth that will cover all the cartridge except one inch. Allow five minutes for freezing, then place cartridge in a freezer and store at minus 20° F or lower. Cartridges should be labeled with the following information: manufacturer's name/CAGE code, specification, date frozen, batch number. Refer to Table 6-1 for information on storage duration.

Table 6-1. Frozen Sealant Storage (MIL-S-8802 and MIL-S-83430)

TEMPERATURE	DURATION (DAYS)
-20°F	14
-40°F	30

- b. Thawing. The time consumed mixing and freezing and thawing sealants reduces total application life. Cartridges may be quick thawed in a bath of warm water (approximately 170° F). Immersion time should not exceed 15 minutes for A2, B2, B6, or C sealants. Excess water shall be wiped from the cartridge prior to issue. The cartridge shall be checked for hot spots. If hot spots are suspected the temperature of the cartridge shall be checked by inserting a thermometer into the sealant. Temperature of the thawed sealant should be between 60° F and 95° F. If the temperature of the thawed sealant exceeds 95° F the cartridge shall be discarded. Stamp or inscribe each cartridge with time of thaw.

**6-7.3 MIXING OF CURING TYPE SEALANTS.** Sealants shall be mixed in accordance with the manufacturer's instructions or this Technical Order. When multiple part curing type sealant is prepared for use the accelerator shall be mixed as appropriate to obtain a thorough and complete mixture. Do not attempt to mix a partial kit without using an accurate scale to obtain proper proportioning of contents. Any sealant or accelerator found to be hard or lumpy shall be discarded. Filling type sealants shall be machine mixed to avoid entrapment of air. Hand mixing is permitted if done in accordance with manufacturer's instructions or this Technical Order. Brushable type sealants may be hand mixed but machine mixing is preferred for large quantities. Hand mixing should be accomplished on a flat plate to

avoid trapping air. For small hand mixed batches of brush type, Class A sealant, mixing may be accomplished in the base material container if care is taken not to entrap air in the sealant.

**6-7.4 APPLICATION LIFE OF SEALANTS.** Non-curing sealants have an unlimited application life. Curing type sealants have an application life or time during which the sealant remains suitable for use. Application time for multiple part sealants is the time that the mixed sealant remains suitable for application with a brush, injection gun or extrusion gun. Application life is based on standard conditions of 75° F and 50 percent relative humidity. Temperature and application life have an inverse relationship (refer to Table 6-2). Sealant shall not be used, regardless of time, when it will no longer readily wets the surface to which is being applied or is beyond its established application life.

**6-7.5 TACK-FREE TIME.** The tack-free time of a sealant is the time required for a sealant to cure to the point at which the outer surface will not stick to a plastic film (refer to Table 6-2). The tack free condition can be tested by either touching a piece of plastic or a sealing gun nozzle to the sealant. If no sealant transfers, the sealant is tack-free. Fuel tanks shall not be filled until sealant is tack-free.

**6-7.6 FUELING TIME.** Fueling time is the time required for PR1826 and PR 1828 to cure to 30 Shore A, hardness. Fuel tanks shall not be filled until the fueling time has elapsed.

Table 6-2. Tack Free Time (In Hours)

## A-1/2 AND B-1/2 MATERIALS (MIL-S-8802 AND MIL-S-83430)

TEMPERATURE (°F)	35% RH	50% RH	65% RH	90% RH
50	40	35	30	20
55	34	24	19	15
60	30	20	18	12
65	25	18	12	9
70	22	13	9	7
75	19	12	8	4
80	18	9	7	3
85	13	8	5	2
90	12	7	4	2
95	10	5	3	1
100	9	4	2	1
105	8	3	2	
110	7	2	1	

## A-2 AND B-2 MATERIALS (MIL-S-8802 AND MIL-S-83430)

TEMPERATURE (°F)	35% RH	50% RH	65% RH	90% RH
50	160	140	120	80
55	135	95	75	60
60	120	80	70	48
65	100	70	45	36
70	85	50	35	28
75	75	45	30	16
80	70	35	25	12
85	50	30	20	10
90	45	25	15	8
95	40	20	10	6
100	35	15	10	4
105	30	10	5	2
110	25	10	5	1

## FUELING TIME (IN HOURS), B-1/4, B-1/2 AND B-2 MATERIALS (PR 1826)

TEMPERATURE (°F)	B-1/4	B-1/2	B-2
20	8	16	64
40	4	8	32
77	1	2	8

**6-7.7 SEALANT CURE.** Curing type sealants require that applied material cure for specified times at standard conditions of 77° F and 50 percent relative humidity. Curing of sealant may be accelerated by applying heat, not to exceed 140° F and/or humidity (or manufacturer's recommendations).

**6-7.8 TESTING OF SEALANTS.**

**6-7.8.1 ALC AND CONTRACTOR MAINTENANCE ACTIVITIES.** This paragraph describes procedures to be applied by ALC and contractor activities when large amounts of curing type sealants are to be tested. A large amount is considered five gallons or more, base material, mixed and/or applied to aircraft fuel tanks in a five day

period. Mixed sealants shall be tested to assure proper quality before being released for production application. This quality assurance test shall include the following:

**6-7.8.2 SAMPLING.**

- Frequency. Representative samples from each newly opened container or as requested by the sealant mixing activity.
- One sample from each hand mixed batch.
- Representative samples from each machined mixed run. (one sample from: first, middle and end of run)
- Label each sample with the following:

- e. Type and class of sealant.
- f. Manufacturer.
- g. Date of manufacture and lot number.
- h. Date mixed.
- i. Run number.

#### 6-7.8.3 LABORATORY TESTING.

- a. An accelerated cure mechanism is acceptable for evaluating laboratory samples provided the cure temperature does not exceed 140° F (or manufacturer's recommendations), and the relative humidity does not exceed 50 percent. Shore A hardness evaluations for laboratory samples should be based on standard curves for hardness versus cure time developed for accelerated cure and for each individual type and class of sealant used.
- b. The following tests should be conducted:
  - (1) Visual inspection of container and contents.
  - (2) Application time.
  - (3) Tack free time.
  - (4) Curing time.
  - (5) Shore A hardness.
  - (6) Peel strength (Use two aluminum panels coated with MIL-C-27725 which have been aged in jet reference fluid seven days at 140° F.)
- c. Refer to the applicable specification for requirements for application time, tack free time, cure time after nine months storage. The material can be extended 1/2 of the original shelf life in accordance with AFM 67-1, VOL 7, PART 3.
- d. Each sealant run, or portion thereof, must pass all laboratory tests prior to being issued for production use.
- e. Machine mixers that meter sealant components shall be on an inspection and calibration schedule.

6-7.8.4 FIELD ACTIVITIES. For mixing of small amounts of curing type sealants use the following instructions:

- a. Spread a thin layer of mixed sealant on a strip of aluminum and visually examine the sealant for small particles of accelerator.

- b. If particles remain after five minutes of mixing dispose of corresponding batch of mixed sealant. After mixing, sealants shall have a minimum application time as specified by its dash number. Sealants that will not wet the surface or spread smooth shall be discarded.

- c. Deleted.

#### 6-8 PERMANENT REPAIRS.

6-8.1 GENERAL. Permanent repairs are those repairs which require no further maintenance to the aircraft, excluding temporary repairs. The fuel leak classifications of Section IV and applicable aircraft technical manuals shall be followed when determining the degree of allowable leakage and corrective action. Those leaks which require permanent repair shall be repaired using the information contained in this manual and the aircraft technical manuals.

#### 6-8.2 NON-CURING TYPE SEALANT REPAIRS.

6-8.2.1 General. If needed locally constructed fixtures or stands may be used to hold the injection gun during overhead operations. Some sealants become stiff when cold. If necessary apply heat to the groove area to aid in flushing out the old sealant. Defuel the aircraft as necessary to facilitate sealant injection. Usually one damaged injection screw will not prevent adequate sealant injection. However, if two or more consecutive injection screws are damaged they shall be replaced.

6-8.2.2 Materials and Equipment Required: Injection gun, nozzles, air source, sealant, tools to remove injection screws, equipment to defuel aircraft.

#### 6-8.2.3 PROCEDURES.

- a. With leak path analysis, review sealing system structure and corrosion repair completed, use the following procedures:
- b. Defuel aircraft below the leak point if necessary.
- c. Remove injection screws as required.
- d. Use injection gun, nozzle, sealant and air pressure required by aircraft technical order.
- e. Load injection gun. Sealant may be either a prepacked cartridge or hand-packed in the gun. If gun is hand-packed, ensure all air pockets are eliminated.

- f. Set air pressure and connect injection gun to air source.
- g. Discharge a small amount of sealant to eliminate trapped air.
- h. Insert nozzle in injection port. Inject sealant until a string of sealant approximately twice as long as the distance between the holes is extruded. This assures the old sealant is removed, all voids are filled and new sealant can adhere to the walls of the groove.
- i. For repair of long leak paths or hard to identify leak exit points remove additional injection screws as necessary. Start at one end of the leak path and remove two injection screws. Repeat injection process. Working toward the other end of the leak path remove one additional injection screw and replace injection screw in previous port. Inject sealant, continue until leak is repaired.
- j. Replace injection screws.

#### 6-8.3 CURING TYPE SEALANT REPAIRS.

##### 6-8.3.1 SEAMS AND SURFACES.

- a. **Prepacked Seals.** Prepacked seals which leak require disassembly to repair, or if disassembly is not practical, the area can be repaired with a sealant overcoat or fillet.
- b. **Injection Seals.** Injection seals may or may not require disassembly to repair.
- c. **Faying Surface Seals.** Faying surface seals normally require disassembly to repair.
- d. **Fillet Seals.** Fillet seals are normally repaired by removal of the old sealant and application of a new sealant fillet.
- e. **Brush Coat or Overcoat Seals.** These types of seals are normally repaired by removal of old sealant and application of new sealant.

6-8.3.2 **Materials and Equipment Required:** Solvent, cheesecloth, scraper, spatula, hooked wire, cutting tool, adhesion promoter, sealant, stiff bristle brush, lint free wiping cloths, abrading material, gauze pads, acid brush, safety container, cotton gloves, chemical resistant gloves, barrier material, equipment to defuel, drain, and purge aircraft.

##### 6-8.3.3 PROCEDURES.

- a. **SURFACE PREPARATION**

- (1) **Repair Damaged Structure or Corrosion.** All structural damage shall be accomplished in accordance with the aircraft technical manuals. Corrosion removal and treatment shall be in accordance with TO 1-1-691 and the applicable aircraft technical manuals. Application or repair of coating MIL-C-27725 shall be in accordance with TO 1-1-8.
- (2) **Removal of Damaged Seals.** Cover bottom of tank, if necessary, with barrier material or wiping cloths to protect tank coating from debris, tools, and other foreign materials. Using spatula or scraper remove defective sealant. Sealant from short prepacked or injection seals may be removed with a hooked wire and a small cutting tool. The entire seal shall be clear to permit complete filling with new sealant. Sealant from faying surfaces and some prepacked surfaces or long injection seals cannot be removed without structural disassembly. Consult prime ALC (SPM) and aircraft technical manuals for disassembly instructions. Defective fillet seals shall be removed and have the ends cut or tapered to approximately a 45 degree angle. Abrade at least 1/2 inch on each end of the fillet to prepare surface for new fillet seal. Place removed sealant in a bag or container. For an injection seal, clear entire channel or groove of old sealant to prevent trapped air from creating a new leak path.
- (3) **Cleaning of Surfaces to be Sealed.** Remove all debris and foreign materials from the tank. Starting from the top clean all surfaces with four-part cleaner or MEK and cheese cloth or gauze pads. The solvent will cause oil, grease, fuel dirt, etc., to float to the surface and make it easy to remove by wiping. Do not allow the solvent to dry. A stiff bristle brush may be used to clean heavy deposits, fasteners, bolts etc. To avoid contaminating the solvent always pour solvent on to the cloth. Change cheesecloth as often as necessary. Wipe area dry with cheesecloth and repeat cleaning process at least one additional time to ensure area is clean. Once the area has been cleaned do not touch surface with bare hands, as oil or dirt will contaminate

the surface and the sealant will not adhere.

- (4) **Covering Exposed Cadmium Plated Parts.** All cadmium plated parts which are to be sealed with curing type sealants specification MIL-S-8802, MIL-S-83430, or MIL-S-81733, should be isolated with either EC1945 or MIL-C-27725. This topcoat shall be fully dried prior to application of adhesion promoter and sealing material.
- (5) **Application of Adhesion Promoter.** Apply a light coat of adhesion promoter to the surfaces that require faying surface seals, fillet seals or prepacked seals. The adhesion promoter may be applied by fine bristle brush or with cheesecloth. Excess adhesion promoter shall be removed by blotting with cheesecloth. The promoter shall be allowed to dry for 30 minutes before sealant is applied. If more than 24 hours have elapsed or the surface has become contaminated since the application of the adhesion promoter the surface shall be recleaned and new adhesion promoter applied. When applying a pre-coat sealant followed by a fillet seal the adhesion promoter can be applied to the tack-free surface of the pre-coat sealant. Adhesion promoter should be discarded when it becomes cloudy.
- b. **SEALANT SELECTION.** Select the proper sealant in accordance with the aircraft technical manuals. Multiple part curing type sealants shall be mixed in accordance with paragraph 6-7.3 and the application time noted. Sealant shall not be used, regardless of time, when it no longer readily wets the surface to which it is being applied or is beyond its established application life.
- c. **SEALANT APPLICATION.** Do not apply sealant to surface if temperature is less than 60°F. A bimetallic thermometer should be used to check surface temperature. A combination of seals may be required at a single leak location.
- (1) **APPLICATION OF BRUSH COAT SEAL.** The brush coat may be used for fillets and is applied 0.10 inch wider than the fillet on either side of the seam. Using a brush, apply a seal of brushable curing type sealant on top of the adhesion promoter. The brush coat

seal is worked into and around crevices, holes, seams, fasteners, and on the surfaces to be sealed. Allow the surface to become tack-free before application of final seal. Brush coats shall not be used over any primary seal.

- (2) **APPLICATION OF FILLET SEAL OR ISOLATION SEAL.**
  - (a) Apply adhesion promoter if required.
  - (b) Insert mixed fillet type sealant into filleting gun.
  - (c) Select nozzle for size of fillet to be applied. Small fillets require a nozzle with a small orifice, likewise large fillets require a nozzle with a large orifice. If necessary set up a locally fabricated device, to simulate the components to be filleted, to help determine orifice size.
  - (d) Apply a bead of sealant. For large repairs apply the sealant in approximately three foot lengths.
  - (e) Work the bead of sealant, with a spatula, to fill all voids in the seam and to remove all trapped air. Removing all trapped air is extremely important to obtaining a leak free service life of the repair.
  - (f) For small fillets, a single bead is all that is required. Shape the fillet to conform to the dimensions shown in figure 6-30 or in accordance with the aircraft technical manual. After the sealant is tack-free examine the fillet for air bubbles. Repeat repair for any air pockets found.
  - (g) For large fillets, a double bead should be applied. Apply a small bead and work into all voids to remove all trapped air. Allow to cure to tack-free and examine for air bubbles. Bubble cavities shall be enlarged to permit easy filling during application of final full bodied fillet.
  - (h) Apply final full bodied fillet and shape to conform to the dimensions shown in figure 6-30 or as required in the aircraft technical manual. After sealant is tack-free examine

for air bubbles. Repeat repair for any air pockets found.

(3) APPLICATION OF INJECTION SEALS.

- (a) Insert the mixed filleting type curing sealant into the injection gun.
- (b) For an open void, inject sealant until it extrudes from the opposite end and then slowly remove injection gun.
- (c) For closed voids, a long injection tip is required to reach the bottom of the void. Inject sealant and slowly remove injection gun while continuing to inject sealant. Completely fill void with sealant. Use care not to trap air in the sealant.

(4) APPLICATION OF FAYING SURFACE SEAL.

- (a) Insert mixed filleting type curing sealant in filleting gun.
  - (b) Apply sealant to faying surfaces. Filleting tip should be large enough to apply a bead of sealant that can be spread over the whole surface and allow some sealant to be squeezed out when the parts are assembled.
  - (c) Spread sealant evenly over entire surface.
- (5) Assemble part and clamp with setup bolts, wing type Cleco fasteners, or other temporary fasteners.
- (a) Install permanent fasteners, retighten fasteners twice within 30 minutes or before the sealant reaches the end of its application time.
  - (b) Remove excess extruded sealant.

6-8.3.4 REPAIR OF CHALKING SEALANT.

- a. As sealant ages it may develop areas of chalking. These will appear as light colored powdery areas on the sealant.
- b. Materials and Equipment Required: Four-part cleaner, MEK, lint-free cheesecloth, stiff bristle brush, safety container, chemical resistant gloves, air operated vacuum cleaner, materials and equipment to apply top-coat, equipment to defuel, drain, and purge aircraft.

c. PROCEDURES.

- (1) Scrub chalky area vigorously with a dry stiff bristle brush. Hold vacuum cleaner hose near work to pick up chalk dust.
- (2) Clean affected area with solvent and cheesecloth. Dry with clean cheesecloth.
- (3) Apply sealant top coat.

6-8.4 FASTENERS.

6-8.4.1 GENERAL. Fasteners used in integral tanks are sealed in a variety of ways. A combination of sealing methods may be used on any single or group of fasteners. Always ensure fasteners are torqued to the proper value before applying sealant. ALC maintenance activities should consult the aircraft documents and remove all temporary repairs and seal the aircraft in accordance with the following or specific weapon system manuals.

6-8.4.2 Materials and Equipment Required.

6-8.4.3 FASTENER REPAIR PROCEDURES.

a. SURFACE PREPARATION.

- (1) Repair Damaged Structure or Corrosion. All structural damage shall be accomplished in accordance with the aircraft technical manuals. Corrosion removal and treatment shall be in accordance with TO 1-1-691 and the applicable aircraft technical manuals. Application or repair of coating MIL-C-27725 shall be in accordance with TO 1-1-8.
- (2) Removal of Damaged Sealant. Cover bottom of tank, if necessary, with barrier material or wiping cloths to protect tank coating from debris, tools, and other foreign materials. Using spatula or scraper remove defective sealant. The entire seal shall be clear to permit complete filling with new sealant. Consult prime ALC (SPM) and aircraft technical manuals for disassembly instructions. Place removed sealant in a bag or container. For an injection seal, clear entire channel or groove of old sealant to prevent trapped air from creating a new leak path.
- (3) Cleaning of Surfaces to be Sealed. Remove all debris and foreign materials from the tank. Starting from the top clean all surfaces with four-part cleaner or MEK and cheese cloth or

- gauze pads. The solvent will cause oil, grease, fuel dirt, etc., to float to the surface and make it easy to remove by wiping. Do not allow the solvent to dry. A stiff bristle brush may be used to clean heavy deposits, fasteners, bolts etc. To avoid contaminating the solvent always pour solvent on to the cloth. Change cheesecloth as often as necessary. Wipe area dry with cheesecloth and repeat cleaning process at least one additional time to ensure area is clean. Once the area has been cleaned do not touch surface with bare hands, as oil or dirt will contaminate the surface and the sealant will not adhere.
- (4) **Covering Exposed Cadmium Plated Parts.** All cadmium plated parts which are to be sealed with curing type sealants specification MIL-S-8802, MIL-S-83430, or MIL-S-81733, should be isolated with either EC1945 or MIL-C-27725. This topcoat shall be fully dried prior to application of adhesion promoter and sealing material.
  - (5) **Application of Adhesion Promoter.** Apply a light coat of adhesion promoter to surfaces that require fillet seals or brush-coat seals. The adhesion promoter may be applied by fine bristle brush or with cheesecloth. Excess adhesion promoter shall be removed by blotting with cheesecloth. The promoter shall be allowed to dry for 30 minutes before sealant is applied. If more than 24 hours have elapsed or the surface has become contaminated since the application of the adhesion promoter the surface shall be recleaned and new adhesion promoter applied. When applying a pre-coat sealant followed by a fillet seal the adhesion promoter can be applied to the tack-free surface of the pre-coat sealant. Adhesion promoter should be discarded when it becomes cloudy.
  - b. **SEALANT SELECTION.** Select the proper sealant in accordance with the aircraft technical manuals. Multiple part curing type sealants shall be mixed in accordance with paragraph 6-7.3 and the application time noted. Sealant shall not be used, regardless of time, when it no longer readily wets the surface to which is being applied or is beyond its established application life.
  - c. **SEALANT APPLICATION.** Do not apply sealant to surface if temperature is less than 60°F. A bimetallic thermometer should be used to check surface temperature. A combination of seals may be required at a single leak location.
  - d. **SELF-SEALING FASTENERS.** Repair by brush coat or replace fastener.
  - e. **FASTENERS WITH SEALING WASHERS OR O-RINGS.** Torque fastener to specifications if this does not stop the leak remove the fastener and inspect the O-ring for nicks, cuts, abrasions, deterioration, or deformation. If any of these conditions are found replace the O-ring and reinstall the fastener. If the O-ring is not damaged or if replacing the O-ring does not stop the leak replace the fastener or apply a click patch.
  - f. **FASTENERS LOCATED IN SEALANT GROOVES.** Repair by injection of non-curing sealant or apply click patch.
  - g. **FASTENERS SEALED BY BRUSH-COAT AND FILLET.** Repair using the following procedures.
    - (1) **Materials and Equipment Required.** Scraper, solvent, lint-free cheese cloth, acid brush, adhesion promoter, sealant, filleting gun, spatula.
    - (2) **Procedure.**
      - (a) **APPLICATION OF BRUSH COAT SEAL.** The brush coat may be used for fillets. Shape the fillet to conform to the dimensions shown in figure 6-30 or in accordance with the aircraft technical manual. Using a brush, apply a seal of brushable curing type sealant on top of the adhesion promoter. The brush coat seal is worked into and around crevices, holes, seams, fasteners, and on the surfaces to be sealed. Allow the surface to become tack-free before application of final seal. Brush coats shall not be used over any primary seal. After the sealant is tack-free examine the sealant for air bubbles. Repeat repair for any air pockets found.
      - (b) **APPLICATION OF FILLET SEAL.**
        - (A). Insert mixed fillet type sealant into filleting gun.

(B). Select nozzle for size of fillet to be applied. Small fillets require a nozzle with a small orifice, likewise large fillets require a nozzle with a large orifice. If necessary set up a locally fabricated device, to simulate the components to be filleted, to help determine orifice size.

(C). Apply a bead of sealant.

(D). Work the bead of sealant, with a spatula, to fill all voids in the sealant and to remove all trapped air. Removing all trapped air is extremely important to obtaining a leak free service life of the repair.

(E). For small fillets, a single bead is all that is required. Shape the fillet to conform to the dimensions shown in figure 6-30 or in accordance with the aircraft technical manual. After the sealant is tack-free examine the fillet for air bubbles. Repeat repair for any air pockets found.

h. FASTENERS SEALED WITH DOME NUTS. Repair by brush coat or replace dome nut.

i. WET INSTALLED FASTENERS.

(1) GENERAL. Repair by using the following procedures. The aircraft may not need to be defueled for this procedure

(2) Materials and Equipment Required. Scraper, solvent, lint-free cheese cloth, acid brush, adhesion promoter, sealant, filleting gun, spatula

(3) PROCEDURES

(a) Clean hole and surrounding area with solvent and cheesecloth. A cotton-tipped swab may be used for small holes.

(b) Clean fastener.

(c) Apply adhesion promoter to fastener and walls of hole.

(d) Apply a small bead of curing type filleting sealant around shoulder of fastener.

(e) Install fastener and tighten to proper torque. Final torque shall be applied before sealant reaches the end of its application life.

#### 6-8.5 ACCESS DOORS, COMPONENT DOORS.

6-8.5.1 GENERAL. Access and component doors used in integral tanks are sealed in a variety of ways. A combination of sealing methods may be used to seal a door.

6-8.5.2 Materials and Equipment Required. Sealant, parting agent, desalant, container, lint-free cheesecloth, scraper, spatula, filleting gun, solvent, clear water, equipment to defuel, drain and purge aircraft.

#### 6-8.5.3 SURFACE PREPARATION.

a. Repair Damaged Structure or Corrosion. All structural damage shall be accomplished in accordance with the aircraft technical manuals. Corrosion removal and treatment shall be in accordance with TO 1-1-691 and the applicable aircraft technical manuals. Application or repair of coating MIL-C-27725 shall be in accordance with TO 1-1-8.

b. Removal of Damaged Sealant. Cover bottom of tank, if necessary, with barrier material or wiping cloths to protect tank coating from debris, tools, and other foreign materials. Using desalant, Specification MIL-D-9063, or a spatula or scraper remove defective sealant. The entire seal shall be clear to permit complete filling with new sealant. Place removed sealant in a bag or container.

c. Use of Desalant, Specification MIL-D-9063.

d. For small items or items which have no moving parts, glass, plastic or rubber, soak the items in a container of desalant. If the item cannot be soaked apply the desalant with a brush. After the desalant has been in contact with the sealant for ten minutes rinse non-moving items in clear water. Items with moving parts shall be wiped with a damp cloth. Clean all parts with solvent in accordance with paragraph 6-8.5.3.e.

e. Cleaning of Surfaces to be Sealed. Remove all debris and foreign materials from the

door. Starting from the top clean all surfaces with four-part cleaner or MEK and cheese cloth or gauze pads. The solvent will cause oil, grease, fuel dirt, etc., to float to the surface and make it easy to remove by wiping. Do not allow the solvent to dry. A stiff bristle brush may be used to clean heavy deposits, fasteners, bolts etc. To avoid contaminating the solvent always pour solvent onto the cloth. Change cheesecloth as often as necessary. Wipe area dry with cheesecloth and repeat cleaning process at least one additional time to ensure area is clean. Once the area has been cleaned do not touch surface with bare hands, as oil or dirt will contaminate the surface and the sealant will not adhere.

- f. **Covering Exposed Cadmium Plated Parts.** All cadmium plated parts which are to be sealed with curing type sealants specification MIL-S-8802, MIL-S-83430, or MIL-S-81733, should be isolated with either EC1945 or MIL-C-27725. This topcoat shall be fully dried prior to application of adhesion promoter and sealing material.

**6-8.5.4 SEALANT SELECTION.** Select the proper sealant in accordance with the aircraft technical manuals. A low adhesion curing type sealant is preferred, however, a standard curing type sealant may be used. If a standard curing type sealant is used a parting agent shall be applied to one of the mating surfaces. Multiple part curing type sealants shall be mixed in accordance with paragraph 6-7.3 and the application time noted. Sealant shall not be used, regardless of time, when it no longer readily wets the surface to which is being applied or is beyond its established application life.

#### **6-8.6 DOOR REPAIR PROCEDURES.**

- a. **SEAL REPLACEMENT.** Use the aircraft technical manuals and the following procedures to replace compression type seals such as flat gaskets, O-rings, and bonded in place seals.

- (1) Remove seal from door
- (2) Clean sealing surface of door.
- (3) Replace gasket using proper sealant or adhesive as required.
- (4) Install door and torque fasteners.
- b. **DOOR FASTENER REPAIR.** Leaking door fasteners shall be repaired in accordance with the aircraft technical manual, paragraph 6-8.4, or the following (the tank may not need to be defueled for this procedure):
  - (1) Torque fastener to value required by aircraft technical manual.
  - (2) If leak continues remove fastener.
  - (3) Clean fastener and hole.
  - (4) Apply a bead of filleting type curing sealant to fastener shank.
  - (5) Install fastener and tighten to proper torque. Final torque shall be applied before sealant reaches the end of its application life.

#### **6-8.7 COMPONENT REPLACEMENT PROCEDURES.**

**6-8.7.1 GENERAL.** Use the aircraft technical manuals and the following to repair or replace accessory components such as booster pumps, cover plates, etc., sealed with curing type sealant.

**6-8.7.2 Equipment and Materials Required.** Scraper, parting agent.

##### **6-8.7.3 Procedures.**

- a. Remove old sealant.
- b. Clean components.
- c. Apply parting agent to one surface.
- d. Apply sealant to other surface.
- e. Install and torque attaching hardware.
- f. Fillet seal the edges as required.

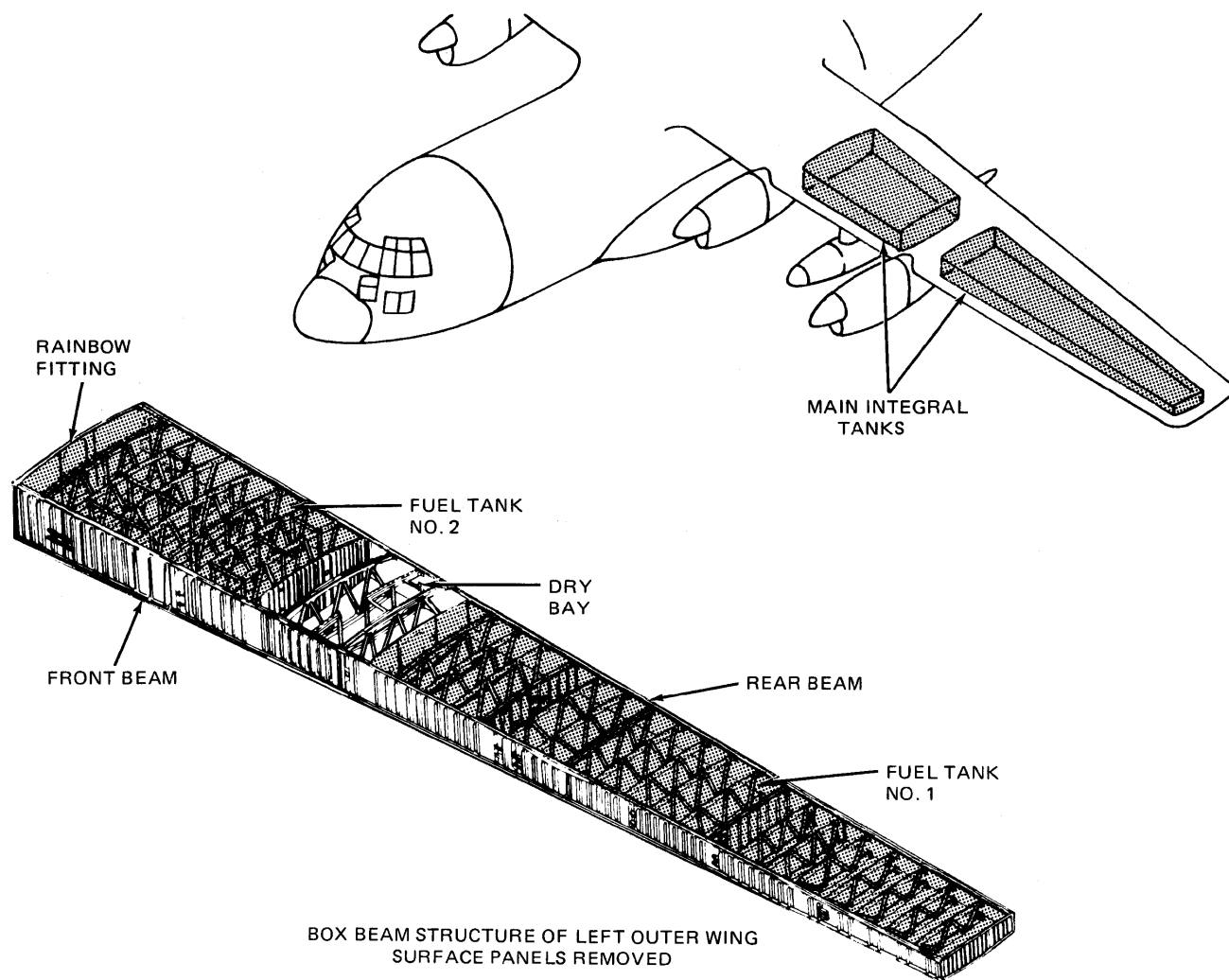


Figure 6-1. Typical Integral Fuel Tanks

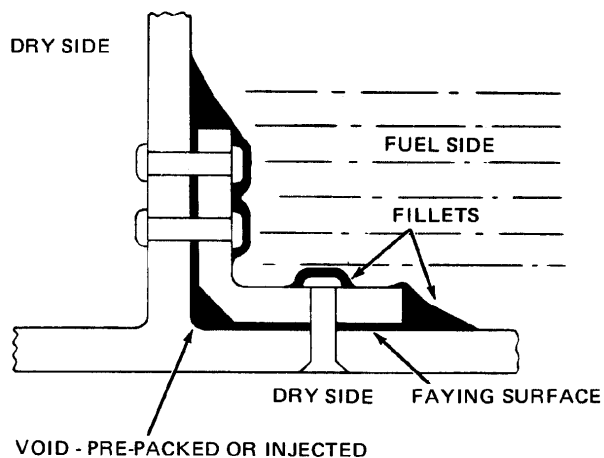
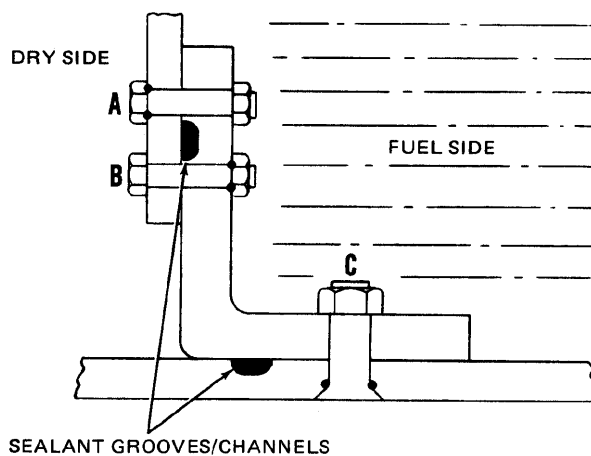


Figure 6-2. Curing Sealant Design



**NOTE**

FASTENER A MAY BE SEALED ON EITHER END. FASTENER B MUST BE SEALED ON NUT END AND FASTENER C MUST BE SEALED IN THE COUNTERSINK.

Figure 6-3. Non-Curing Sealant Design

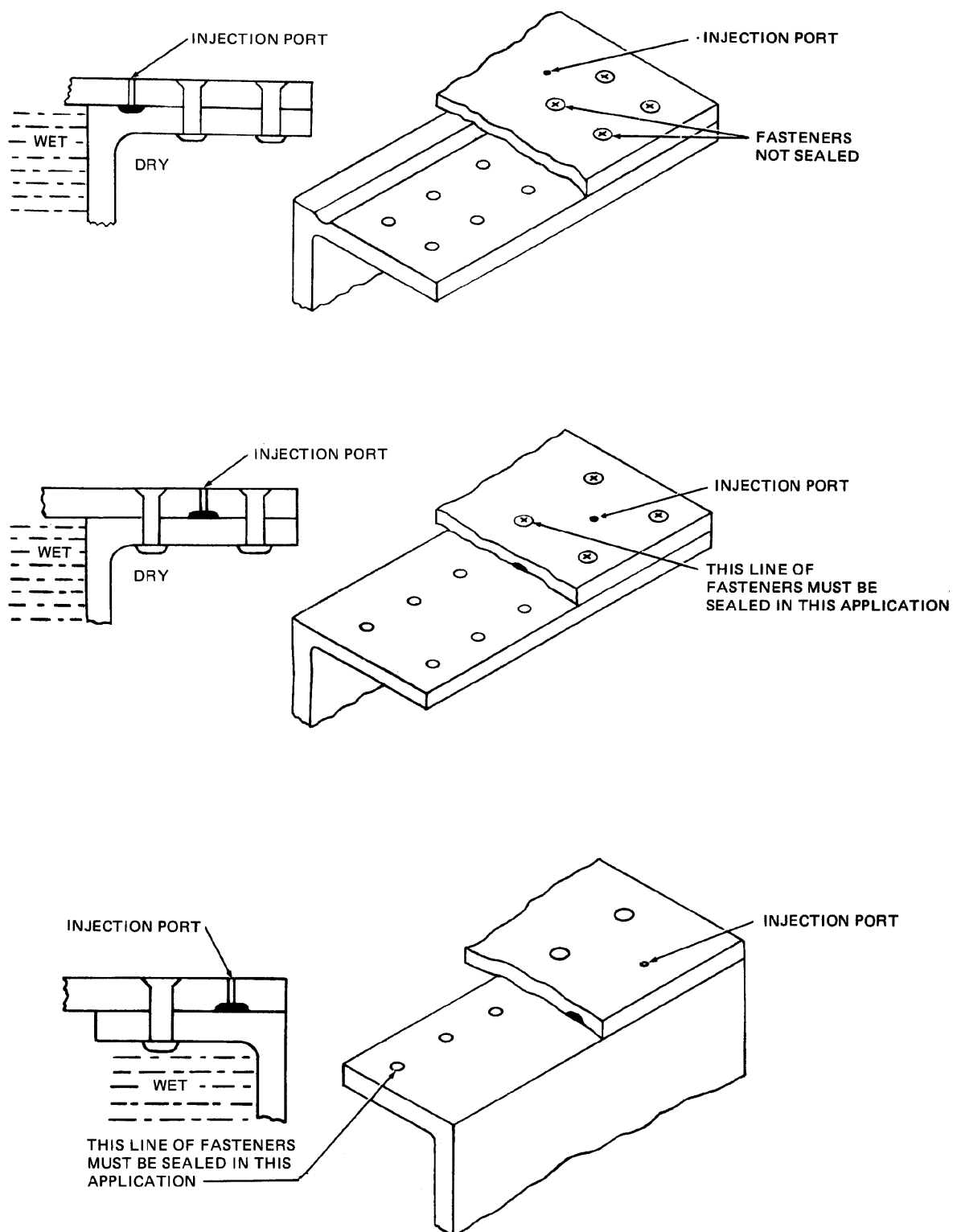


Figure 6-4. Typical Locations of Grooves/Channels (Sheet 1 of 2)

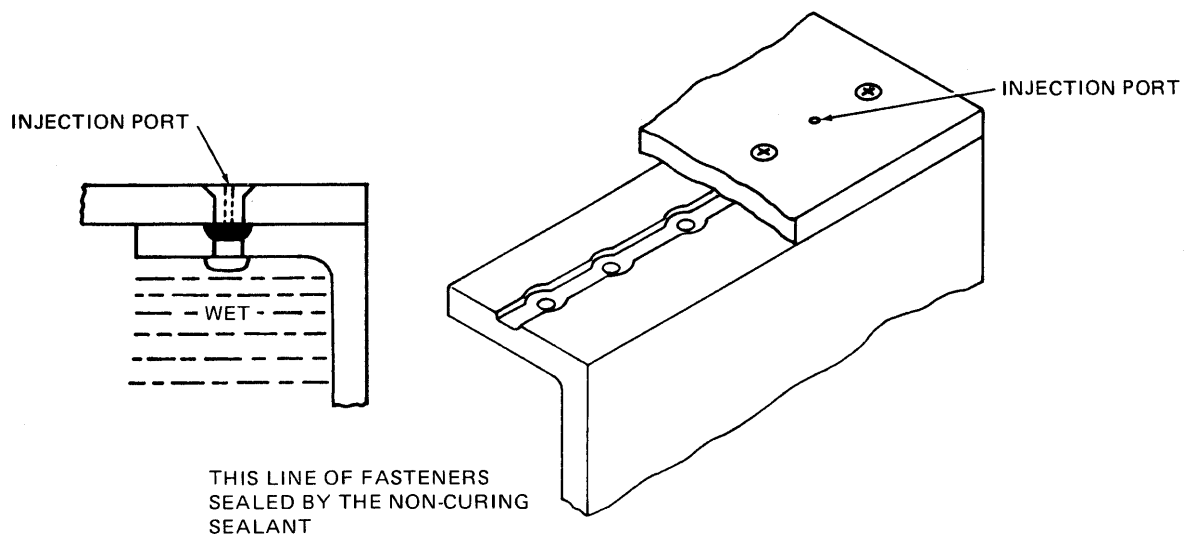


Figure 6-4. Typical Locations of Grooves/Channels (Sheet 2 of 2)

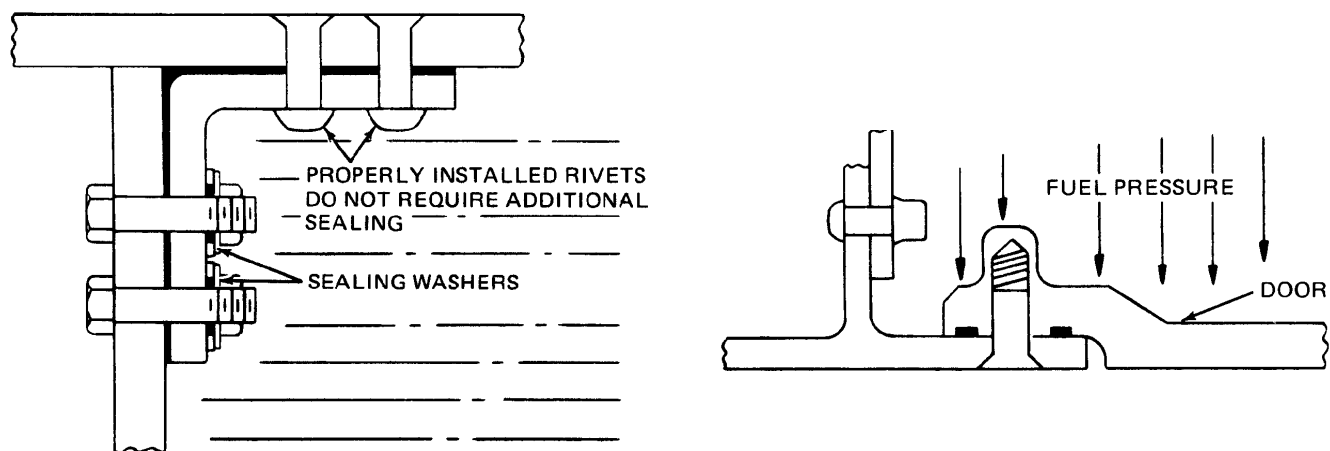


Figure 6-5. Structural Adhesive Sealing

Figure 6-6. Plug Door

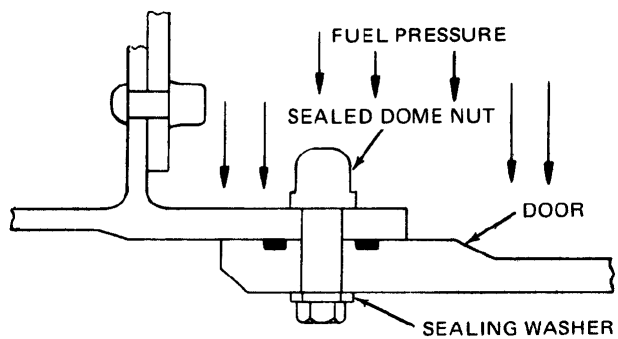


Figure 6-7. Direct Seal Door

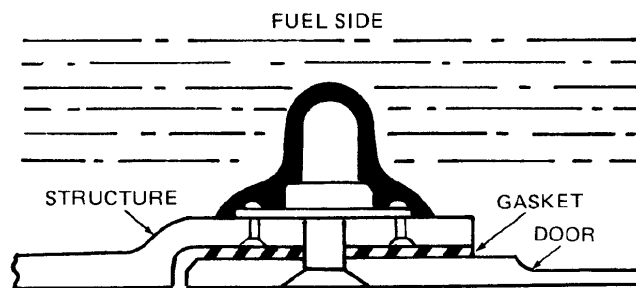


Figure 6-8. Flat Gasket Seal

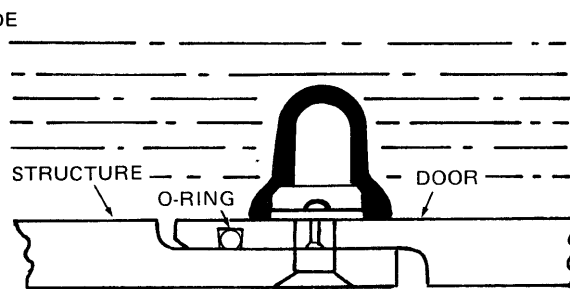
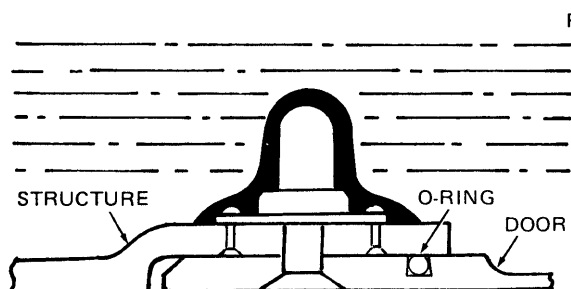


Figure 6-9. O-Ring Seal

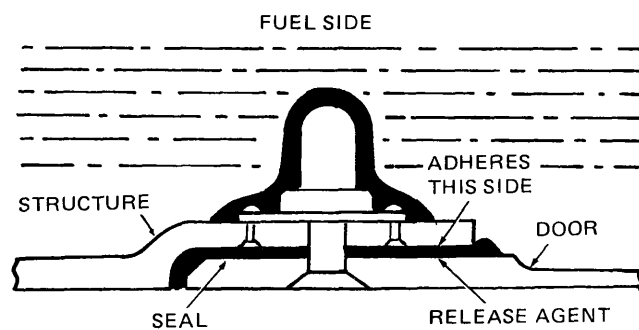


Figure 6-10. Formed-In-Place Seal

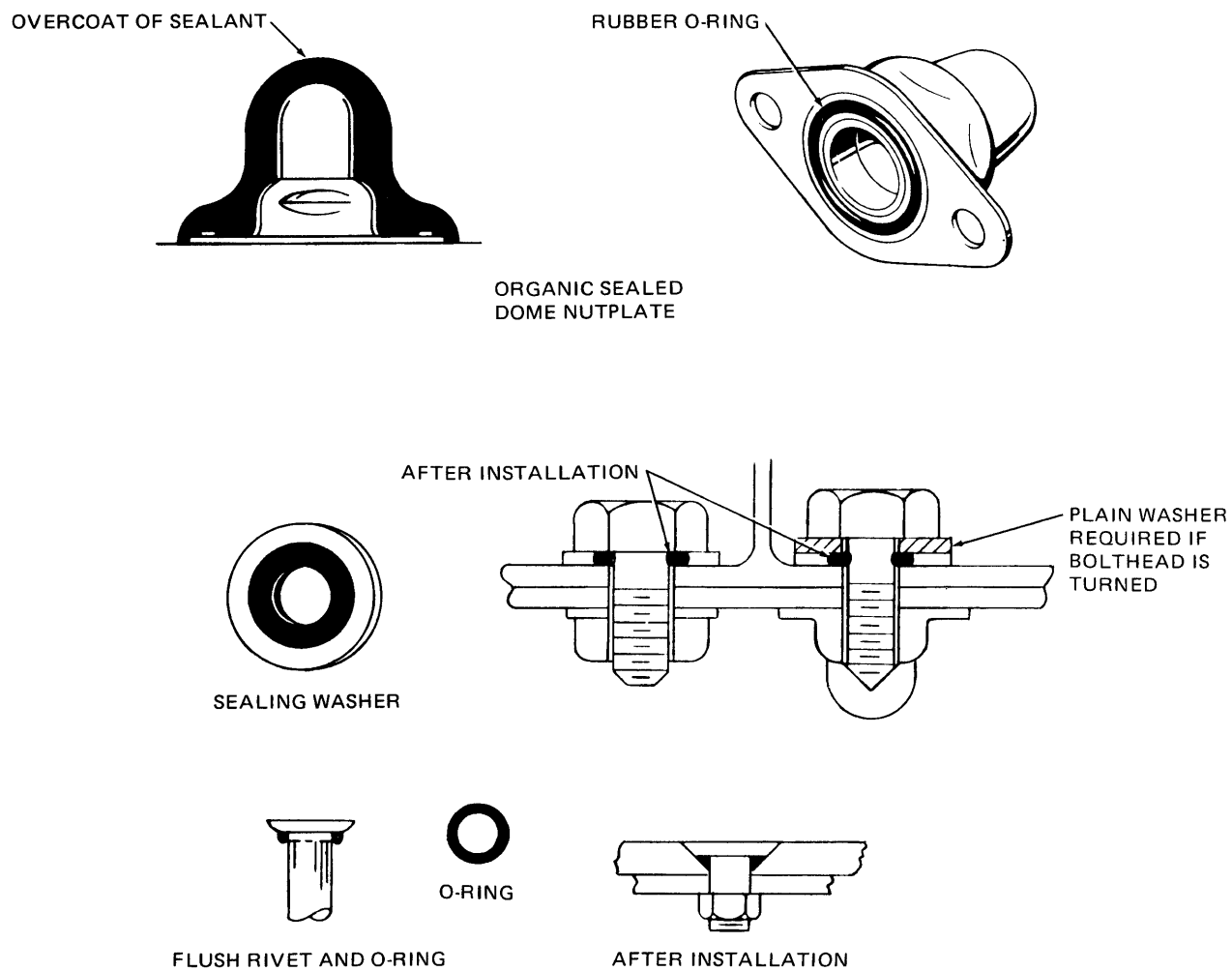


Figure 6-11. Typical Fastener Seals

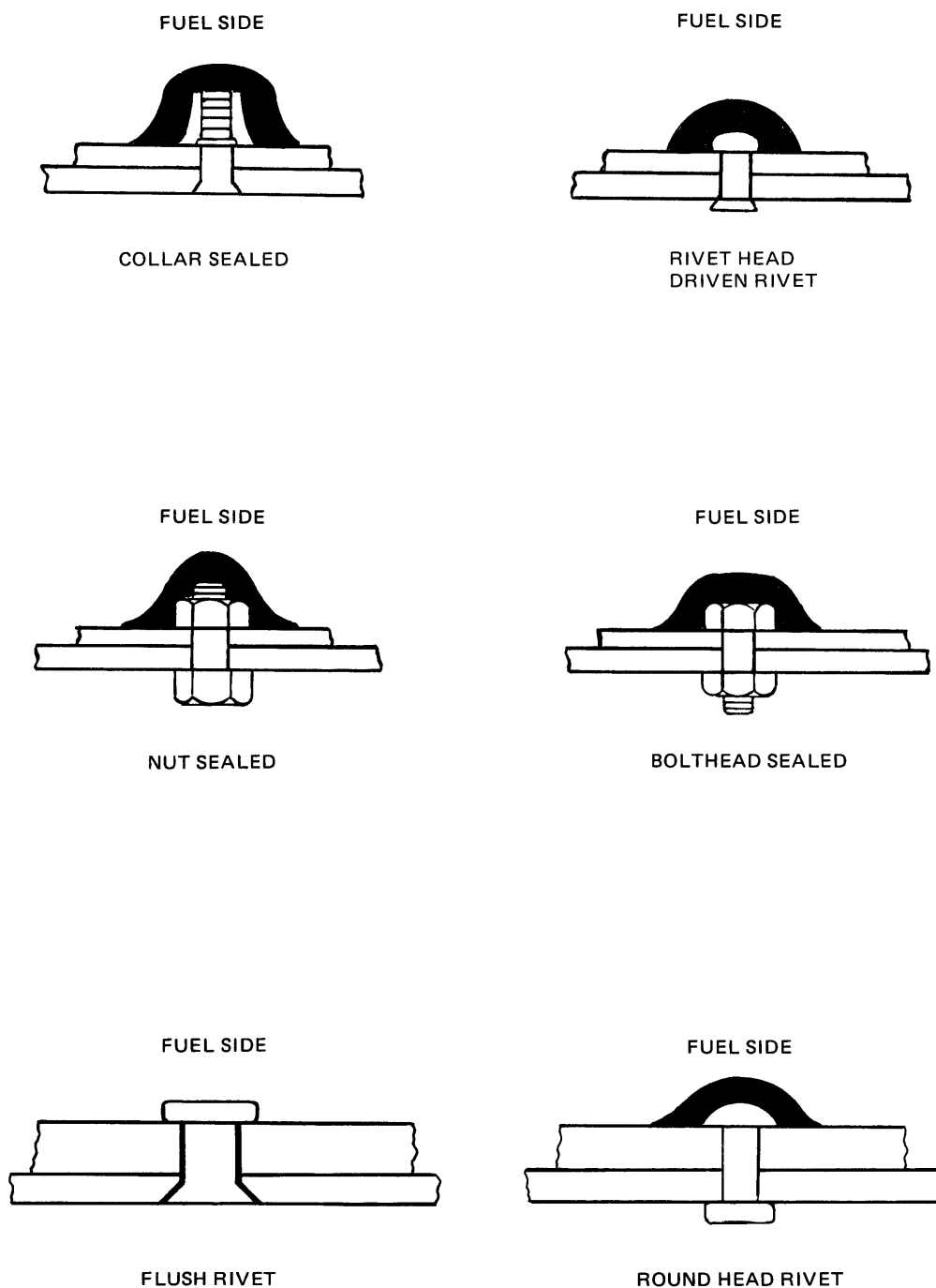


Figure 6-12. Typical Fasteners, Overcoat and Fillet

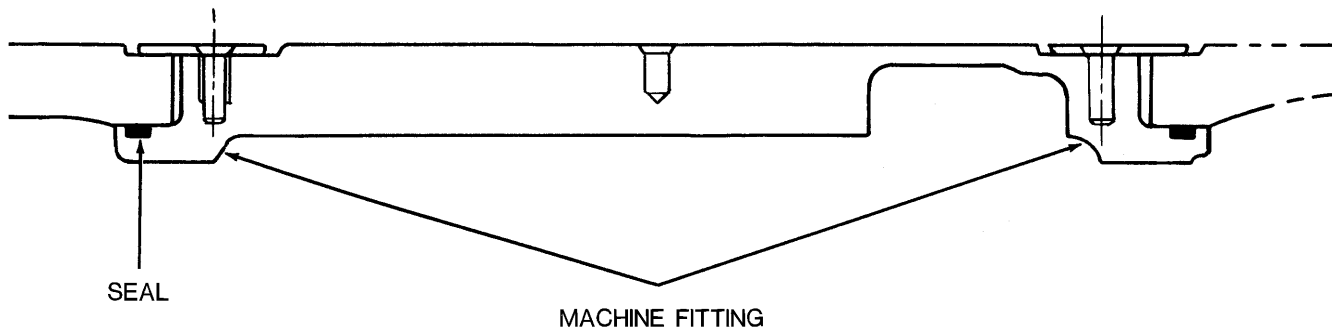


Figure 6-13. Machine Fitted Plug-Type Access Door for Attaching Screws

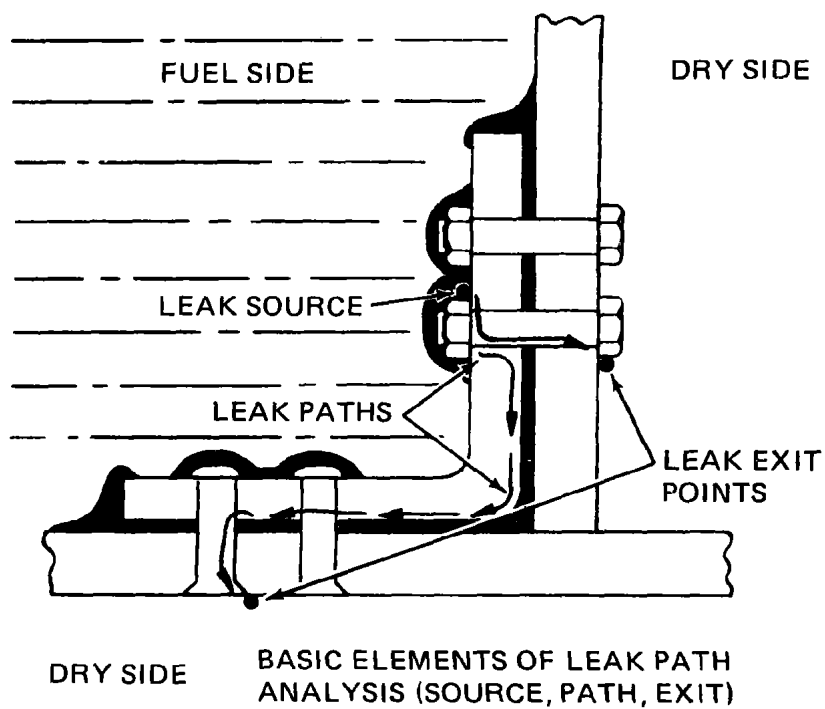


Figure 6-14. Leak Path Analysis

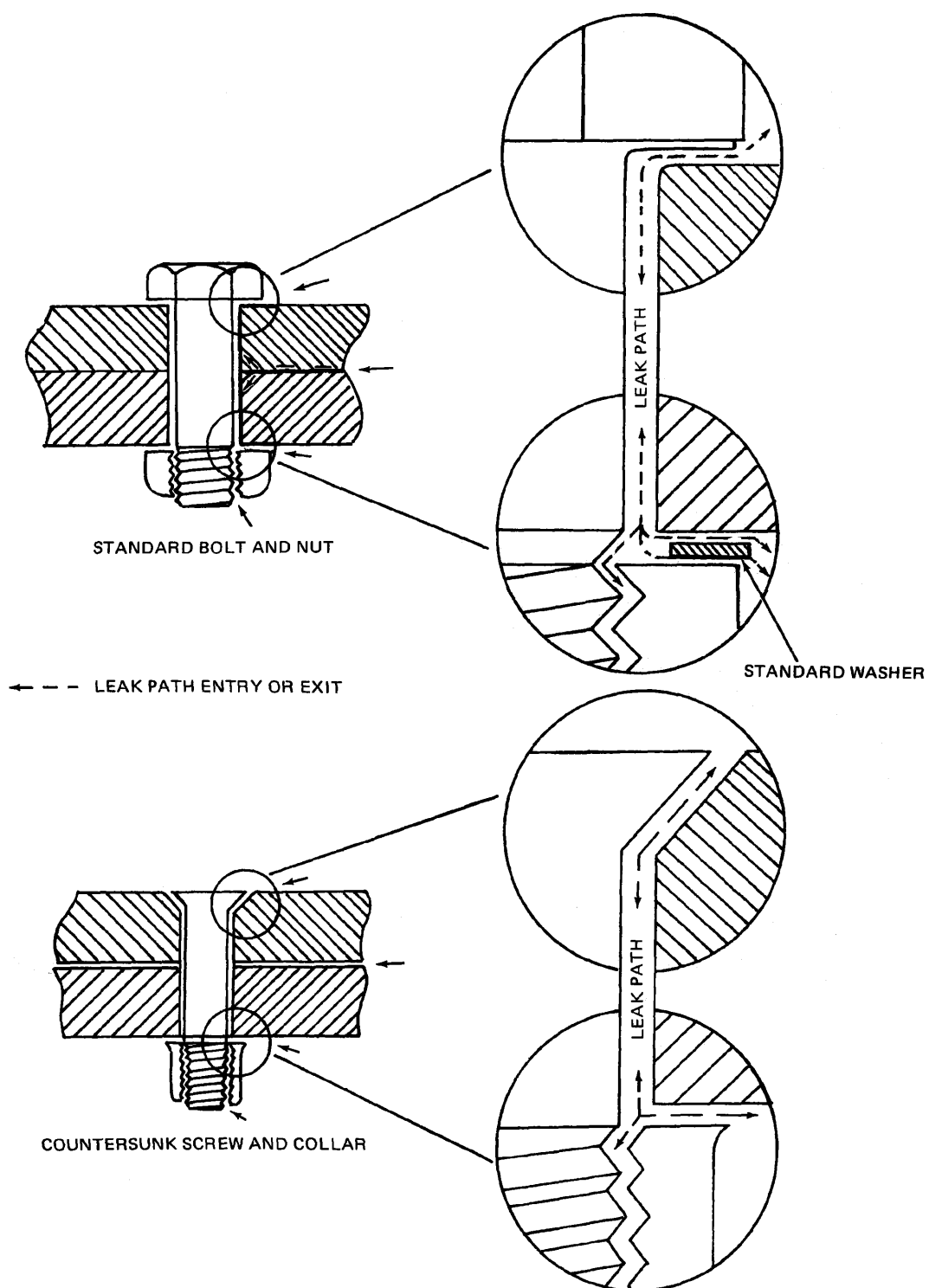


Figure 6-15. Fasteners Leaks

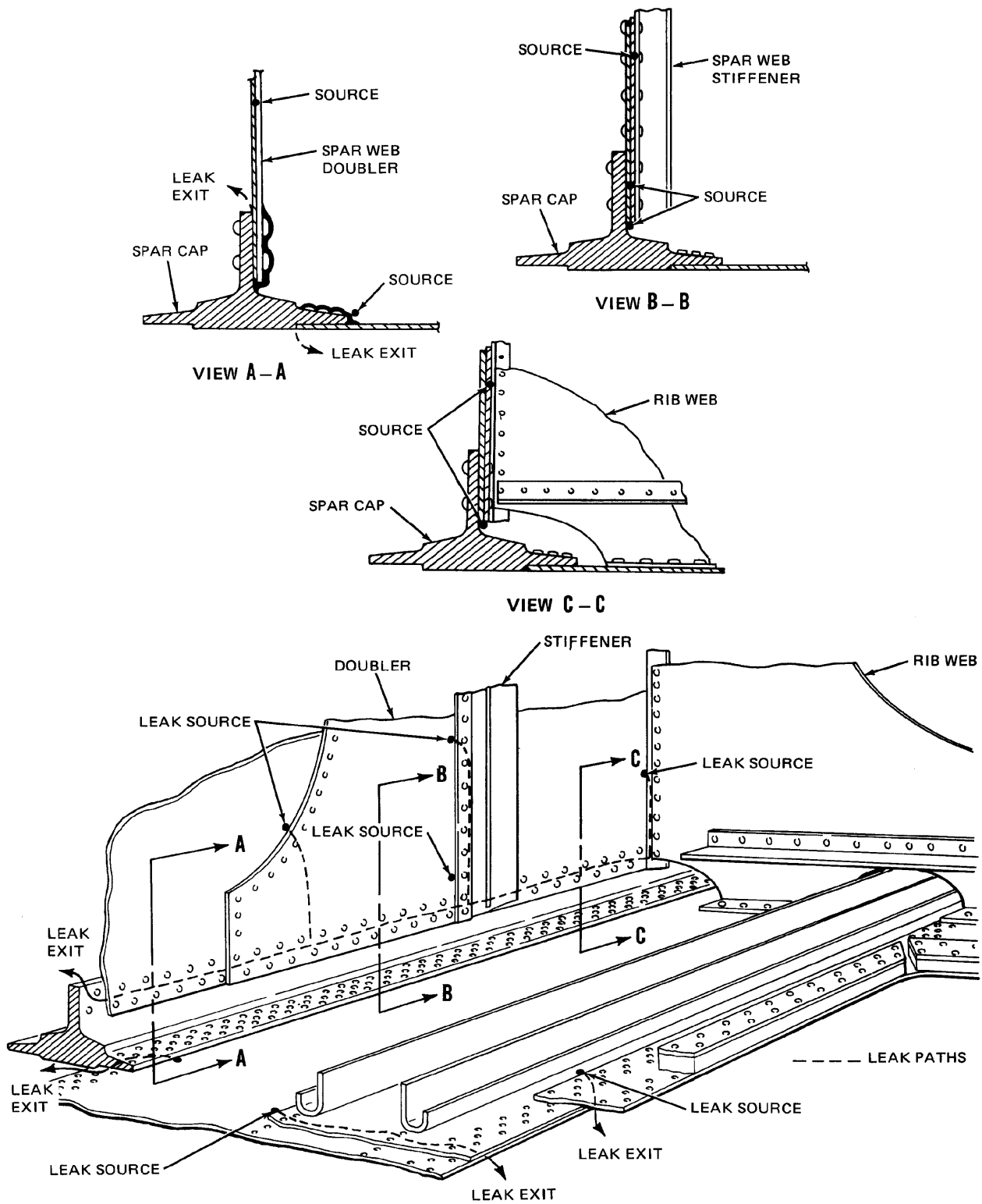


Figure 6-16. Examples of Long Leak Paths

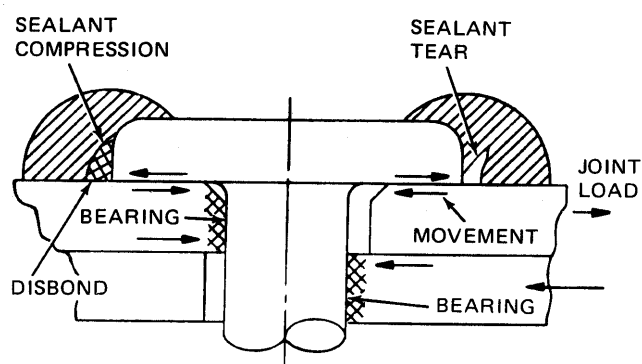


Figure 6-17. Fastener Movement on Oversize Hole

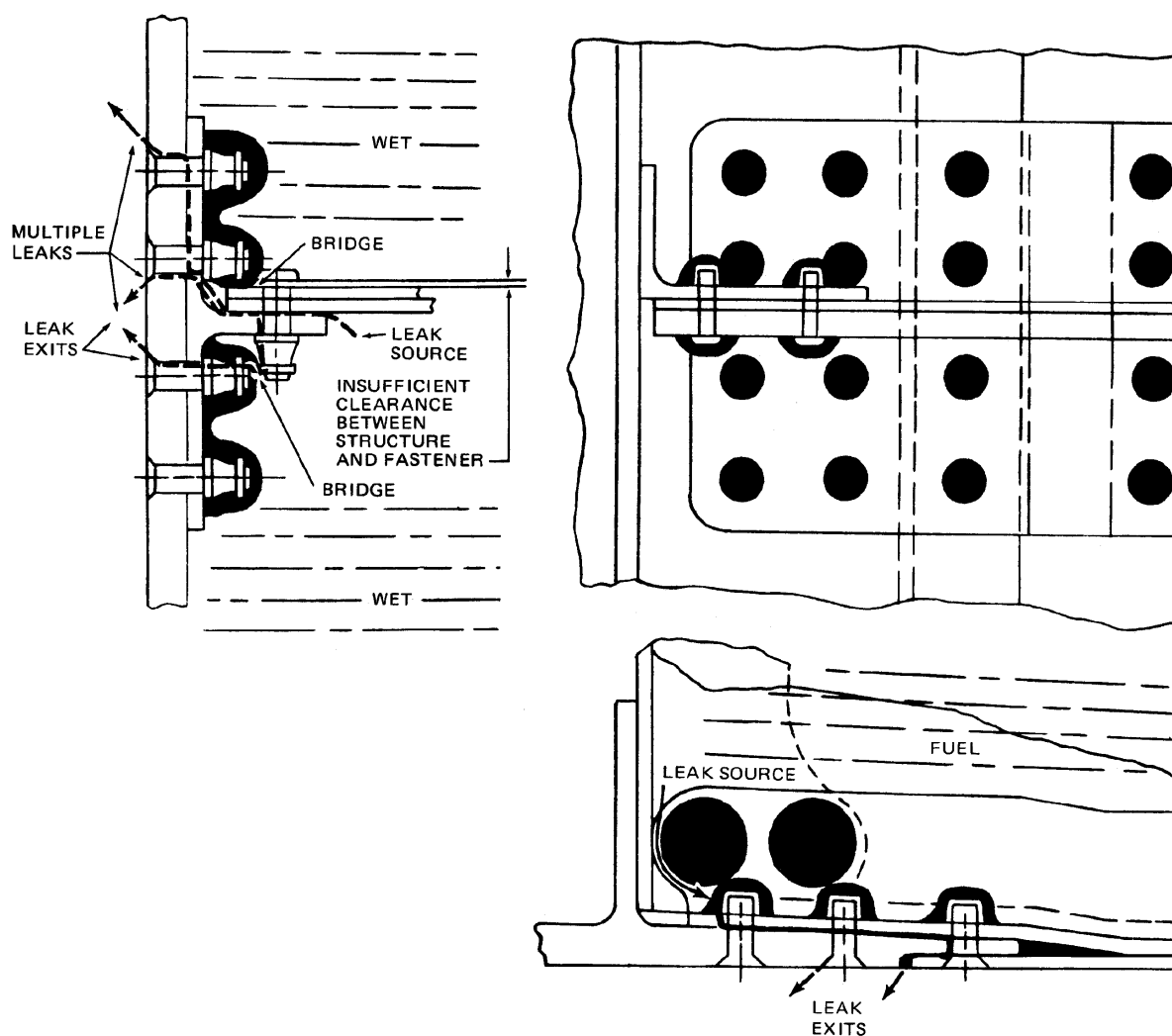
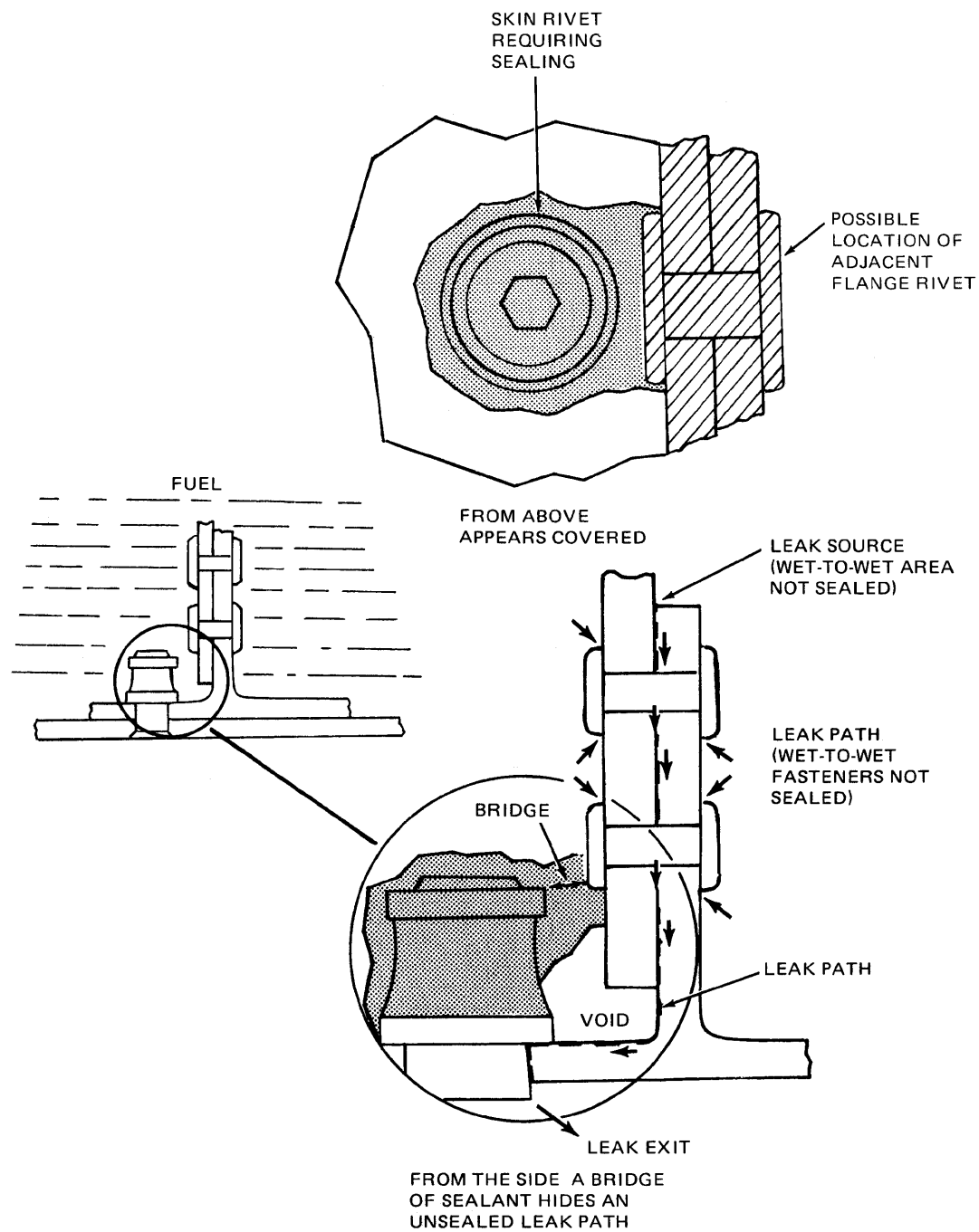


Figure 6-18. Multiple Leak Paths From a Single Leak Source



**NOTE**

SOME LEAK PATHS CAN BE CREATED THAT ARE ALMOST IMPOSSIBLE TO FIND AND SEAL SUCH AS THE CREATION OF BRIDGES BETWEEN CLOSELY POSITIONED FASTENERS.

Figure 6-19. Sealant Bridging

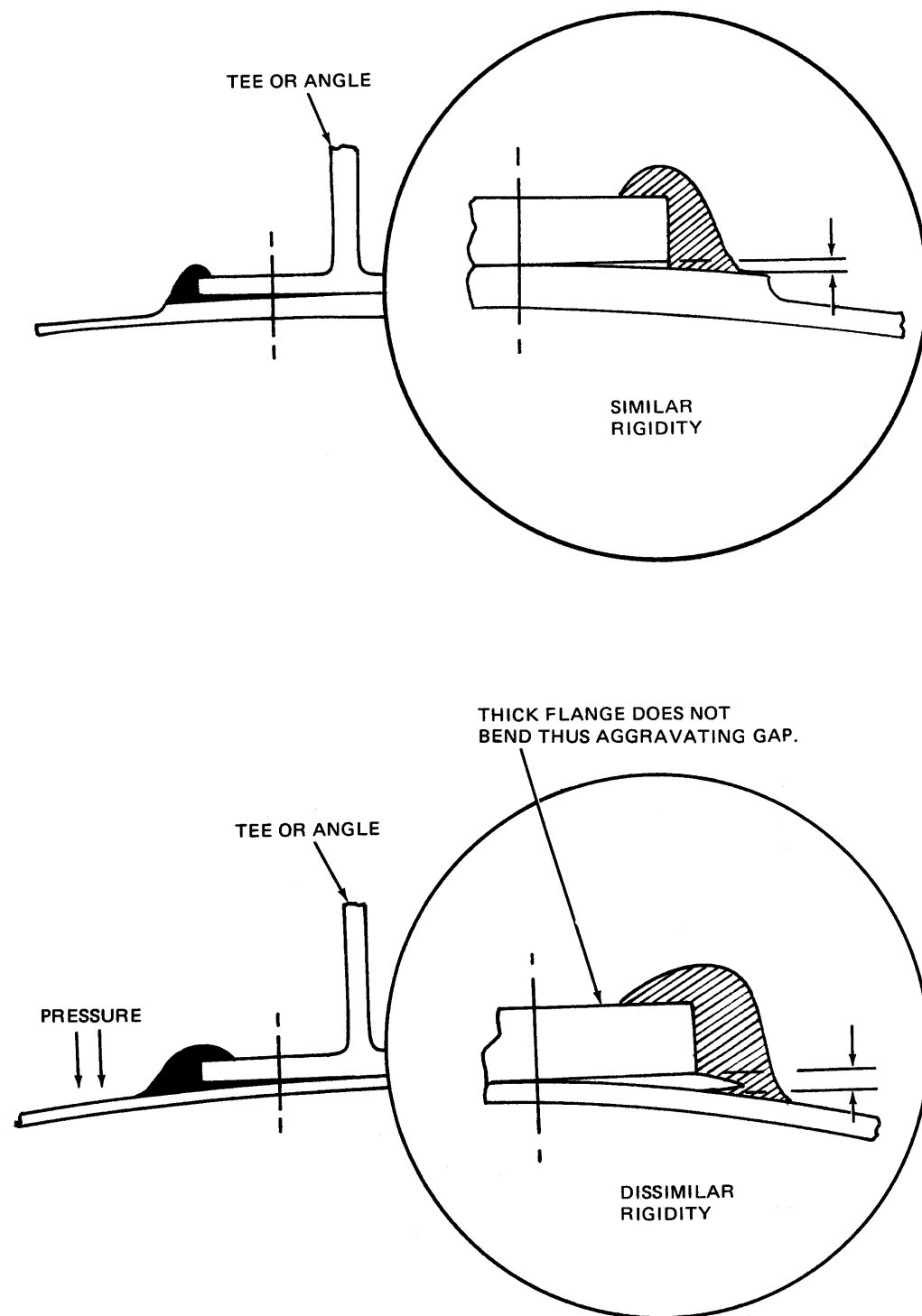
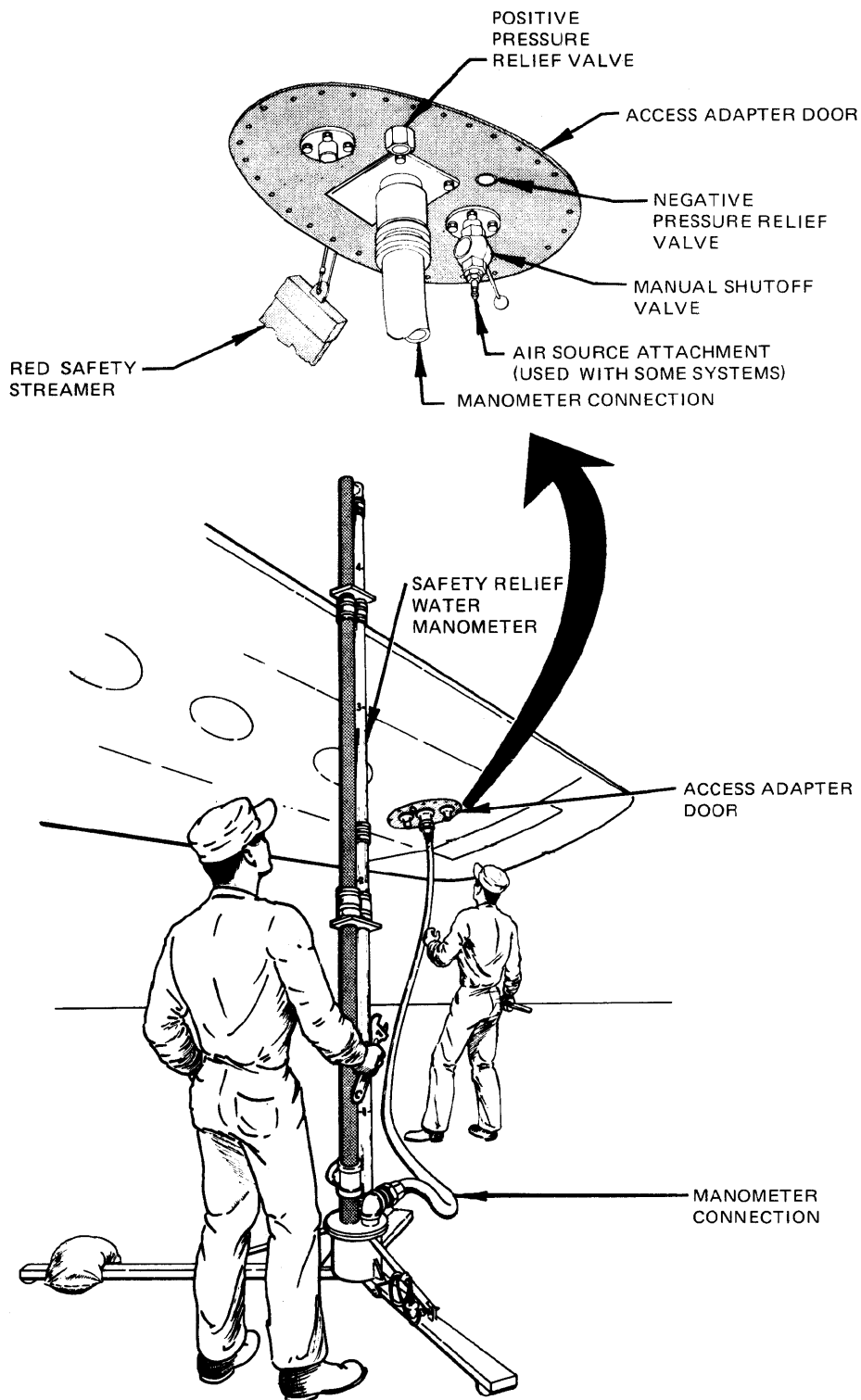


Figure 6-20. Fillet Seal Deflection



L8904222

Figure 6-21. Pressure Test Method

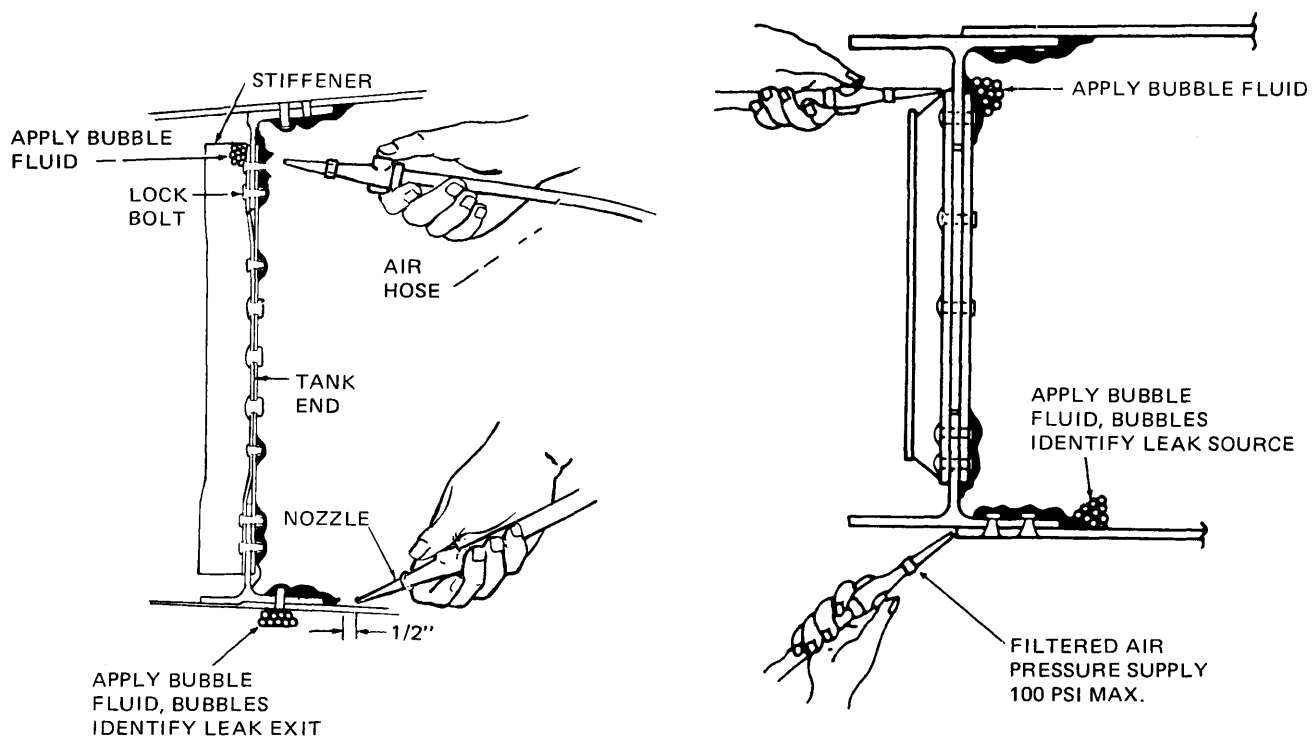


Figure 6-22. Blow Back Method

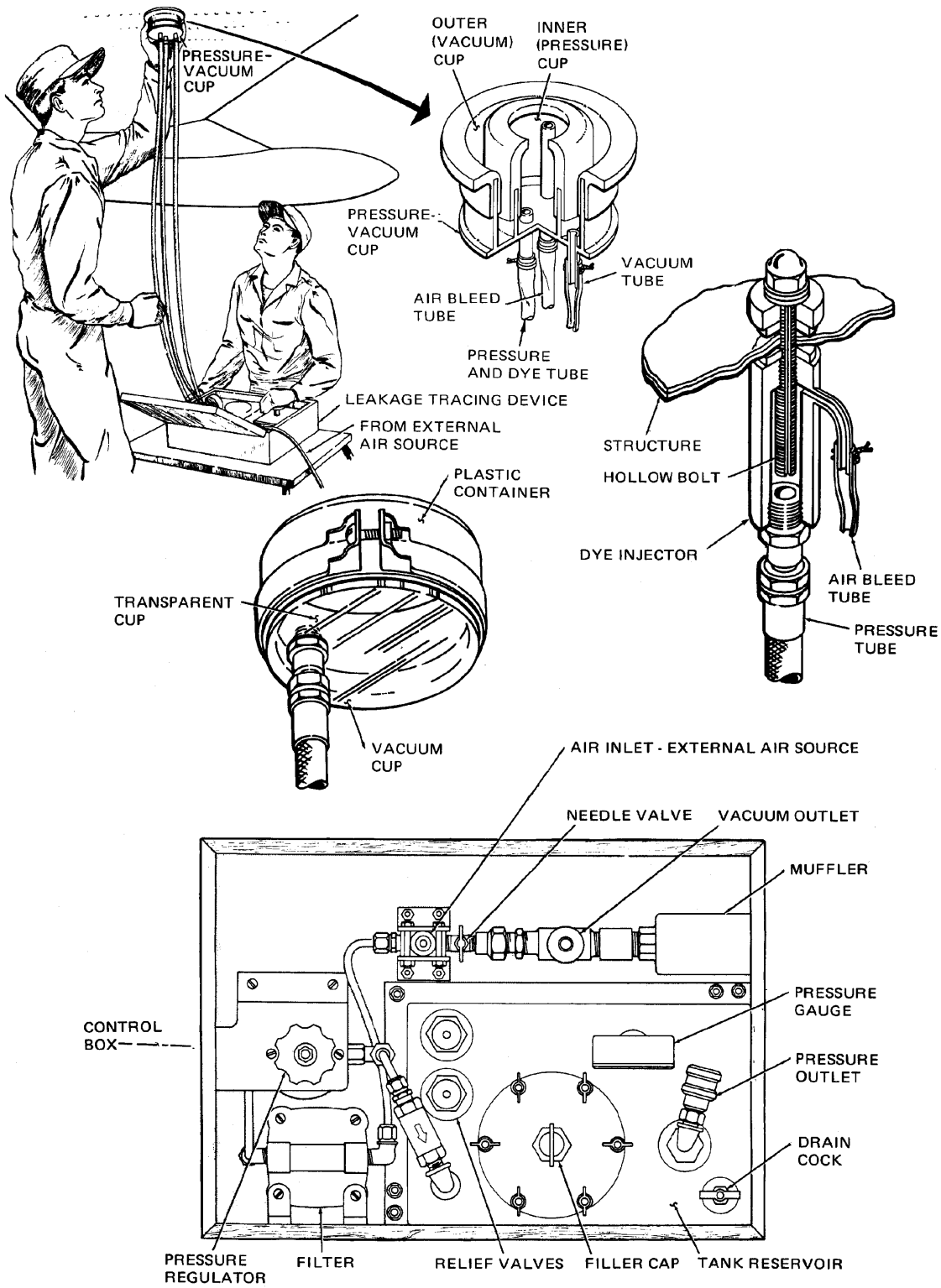


Figure 6-23. Dye Injection Method

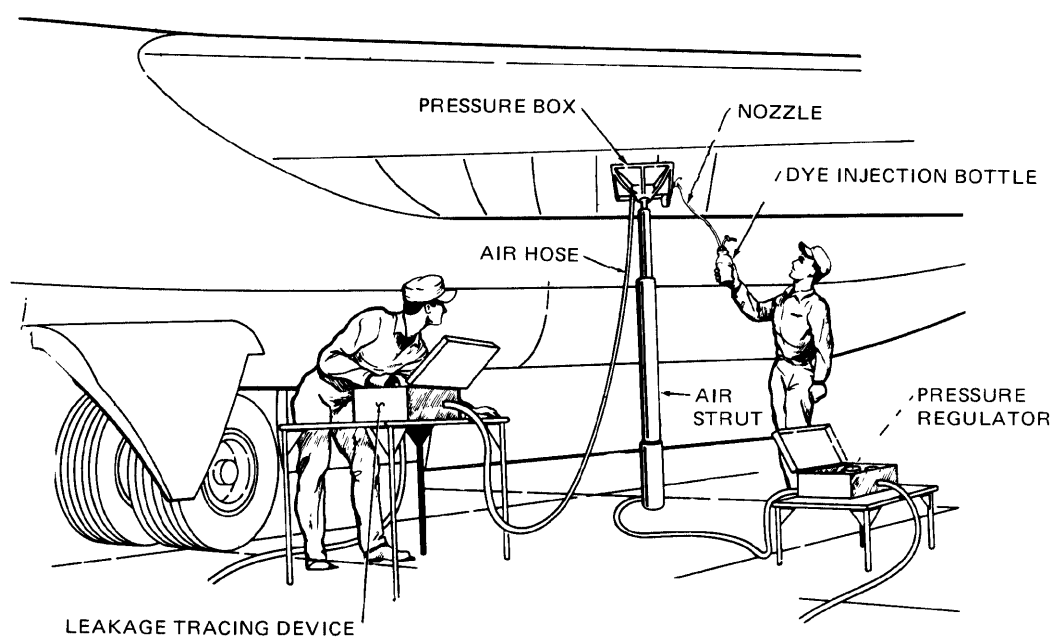
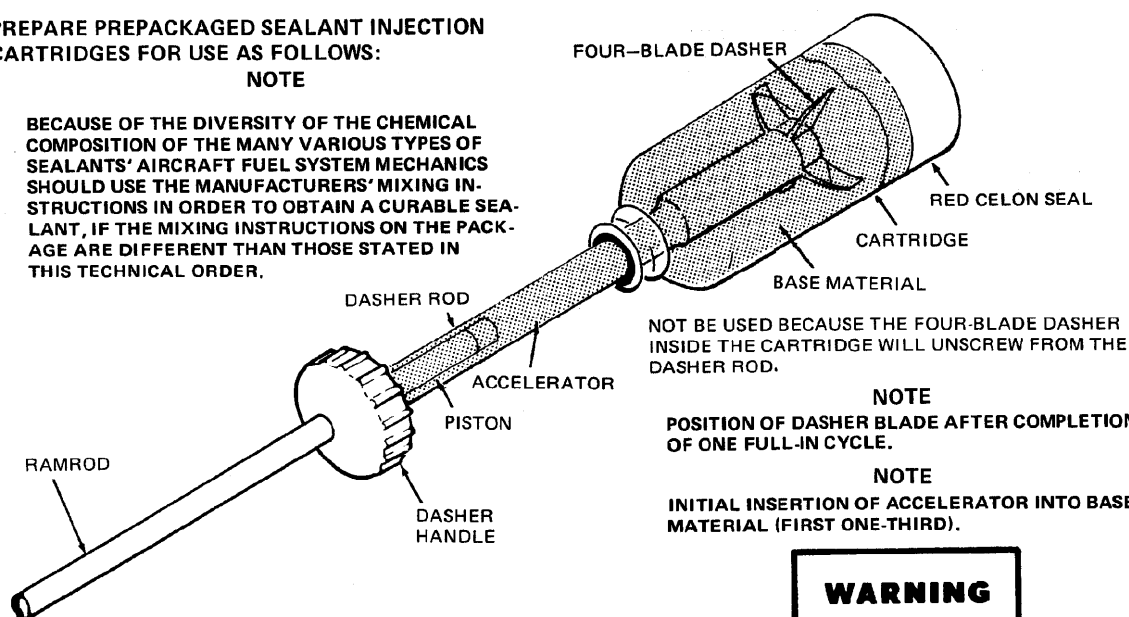


Figure 6-24. Use of Pressure Box for Dye Injection

# PREPARE PREPACKAGED SEALANT INJECTION CARTRIDGES FOR USE AS FOLLOWS:

## NOTE

BECAUSE OF THE DIVERSITY OF THE CHEMICAL COMPOSITION OF THE MANY VARIOUS TYPES OF SEALANTS' AIRCRAFT FUEL SYSTEM MECHANICS SHOULD USE THE MANUFACTURERS' MIXING INSTRUCTIONS IN ORDER TO OBTAIN A CURABLE SEALANT, IF THE MIXING INSTRUCTIONS ON THE PACKAGE ARE DIFFERENT THAN THOSE STATED IN THIS TECHNICAL ORDER.



NOT BE USED BECAUSE THE FOUR-BLADE DASHER INSIDE THE CARTRIDGE WILL UNSCREW FROM THE DASHER ROD.

## NOTE

POSITION OF DASHER BLADE AFTER COMPLETION OF ONE FULL-IN CYCLE.

## NOTE

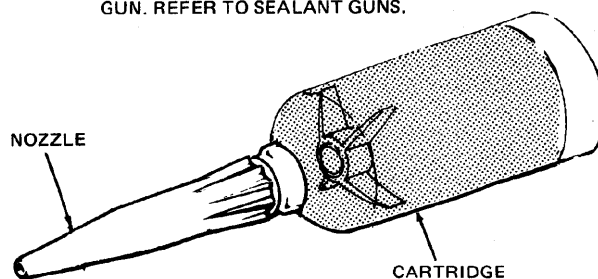
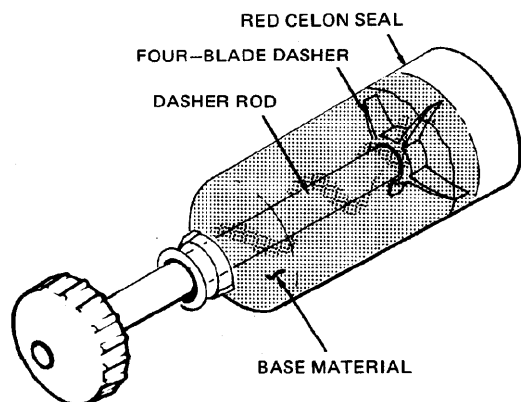
INITIAL INSERTION OF ACCELERATOR INTO BASE MATERIAL (FIRST ONE-THIRD).

## **WARNING**

THE CARTRIDGE SHALL BE HELD FIRMLY, BUT SHALL NOT BE SQUEEZED AS THE DASHER BLADES CAN SEVERELY DAMAGE THE HAND.

1. WEAR SAFETY GLASSES.
2. HOLD CARTRIDGE, GRASP DASHER ROD AND PULL BACK APPROXIMATELY ONE INCH. USE EVEN PRESSURE, DO NOT USE FORCE, TAP, POUND OR JOLT RAMROD IF PISTON DOES NOT BREAK LOOSE READILY.
3. INSERT RAMROD INTO HOLLOW OF DASHER ROD, BREAK PISTON LOOSE AND INJECT ABOUT 1/3 OF THE CONTENTS INTO THE CARTRIDGE. THE RAMROD WILL BE FULLY INSERTED INTO THE DASHER ROD WHEN ALL OF THE ACCELERATOR HAS BEEN FORCED INTO THE CARTRIDGE.
4. REPEAT STEPS 2 AND 3 UNTIL ALL OF THE CONTENTS OF THE ROD ARE EMPTIED INTO THE CARTRIDGE. THEN REMOVE RAMROD.
5. REMOVE AND DISCARD RAMROD.
6. BEGIN MIXING OPERATION BY ROTATING DASHER ROD IN A CLOCKWISE DIRECTION WHILE SLOWLY MOVING DASHER ROD TO FULL OUT POSITION. THE MIXING MUST BE DONE BY A CLOCKWISE ROTATION OF THE DASHER ROD. COUNTERCLOCKWISE ROTATION MUST

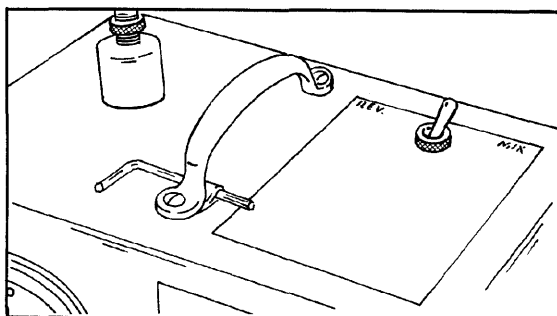
7. CONTINUE CLOCKWISE ROTATION AND SLOWLY MOVE DASHER ROD TO FULLY IN POSITION. A MINIMUM OF FIVE FULL CLOCKWISE REVOLUTIONS MUST BE MADE FOR EACH FULLY OUT STROKE AND FOR EACH FULLY IN STROKE OF THE DASHER ROD. MIX 5 MINUTES OR 50 CYCLES.
8. END MIXING ACTION WITH DASHER ROD IN FULL OUT POSITION.
9. WHILE HOLDING CARTRIDGE IN AN UPRIGHT POSITION, UNSCREW DASHER ROD BY GRIPPING DASHER BLADES IN AREA OF RED CELON SEAL AND TURNING DASHER ROD COUNTERCLOCKWISE.
10. SCREW NOZZLE INTO CARTRIDGE IF SEALANT FILLETING GUN IS TO BE USED.
11. REMOVE RED CELON SEAL AND TEST SEALANT TO INSURE THOROUGH MIXING ACTION HAS BEEN COMPLETED. IF NOT, DISCARD AND REPEAT PROCEDURES WITH NEW CARTRIDGE.
12. INSERT CARTRIDGE INTO APPLICABLE SEALANT GUN. REFER TO SEALANT GUNS.



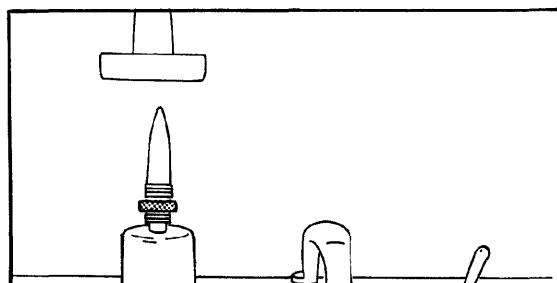
## NOTE

POSITION OF DASHER BLADE AFTER COMPLETION OF MIXING AND REMOVING OF DASHER ROD.

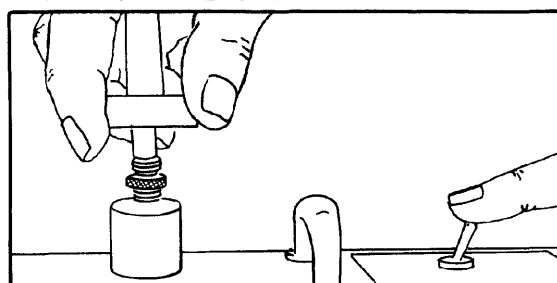
Figure 6-25. Hand Mixing of sealant Kit



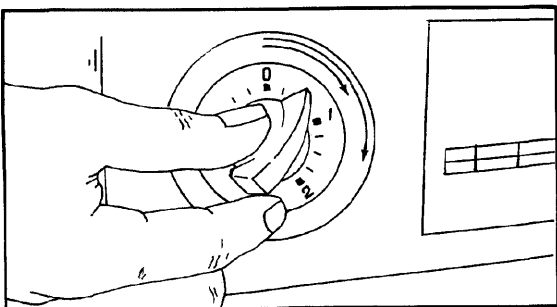
1. PLACE SELECTOR SWITCH IN "MIX" POSITION.



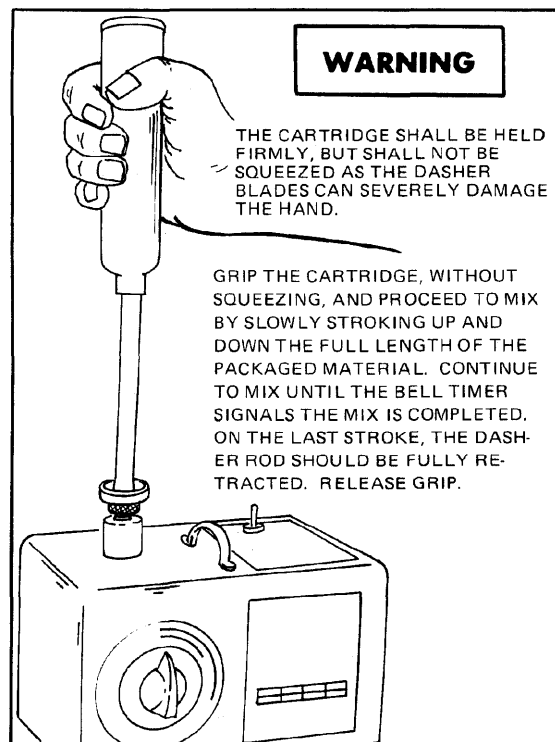
2. AFTER THE CARTRIDGE HAS BEEN PREPARED AS REQUIRED IN FIGURE 6-25, OPERATIONS 1 THROUGH 4, REMOVE RAM ROD AND PLACE THE HOLE OF THE DASHER ROD DOWN OVER THE PILOT OF THE ROTATING SPINDLE.



3. GRIP THE HANDLE OF THE DASHER ROD AND HOLD FIRMLY UNTIL IT IS ENGAGED WITH THE SELF-TAPPING SCREW.



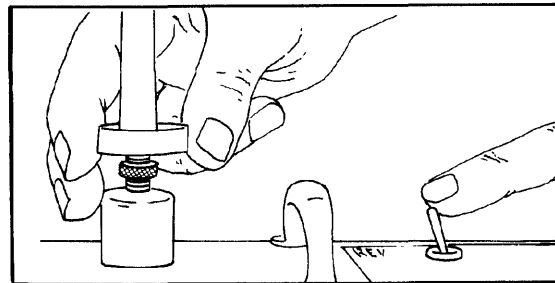
4. SET BELL TIMER TO THE REQUIRED TIME CYCLE.



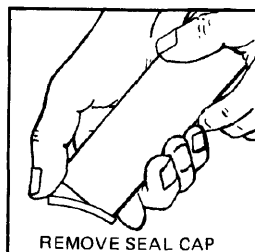
### WARNING

THE CARTRIDGE SHALL BE HELD FIRMLY, BUT SHALL NOT BE SQUEEZED AS THE DASHER BLADES CAN SEVERELY DAMAGE THE HAND.

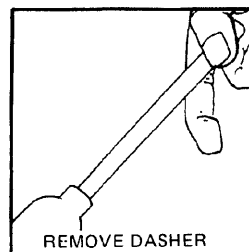
GRIP THE CARTRIDGE, WITHOUT SQUEEZING, AND PROCEED TO MIX BY SLOWLY STROKING UP AND DOWN THE FULL LENGTH OF THE PACKAGED MATERIAL. CONTINUE TO MIX UNTIL THE BELL TIMER SIGNALS THE MIX IS COMPLETED. ON THE LAST STROKE, THE DASHER ROD SHOULD BE FULLY RETRACTED. RELEASE GRIP.



5. REMOVE CARTRIDGE FROM THE MIXER BY PLACING THE SELECTOR SWITCH IN "REVERSE" POSITION. GRIP DASHER ROD HANDLE FIRMLY AND LIFT CARTRIDGE FROM MIXER.



REMOVE SEAL CAP



REMOVE DASHER

6. REMOVE SEAL CAP AND DASHER ROD. CARTRIDGE IS NOW READY FOR USE IN EITHER THE FILLETING GUN OR THE INJECTION GUN. THE INJECTION GUN USES 650 CARTRIDGE ONLY.

Figure 6-26. Machine Mixing of Cartridges

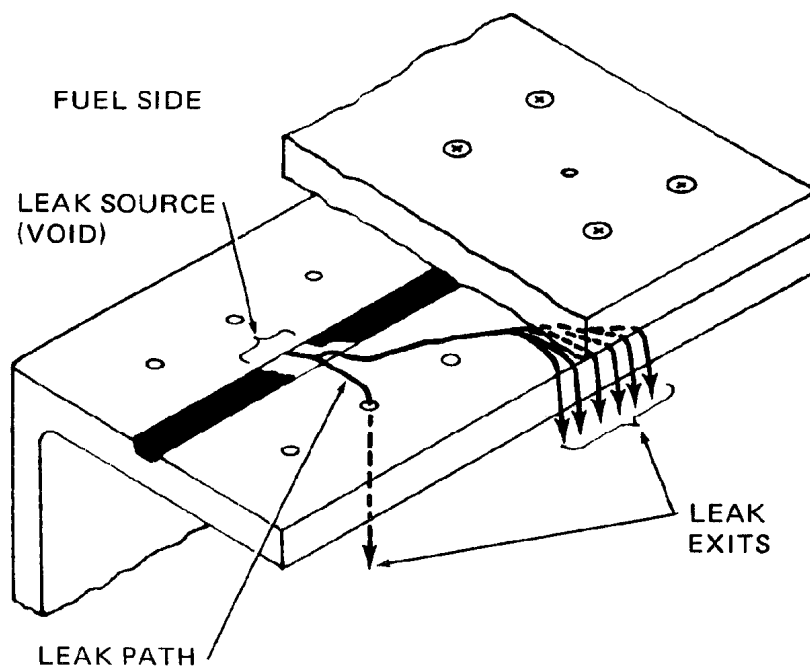


Figure 6-27. Void in Non-Curing Sealant Groove

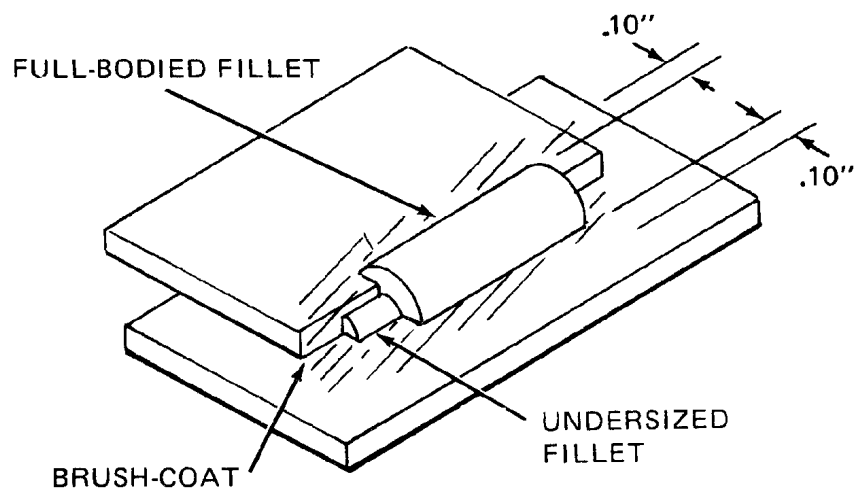


Figure 6-28. Two Bead Fillet

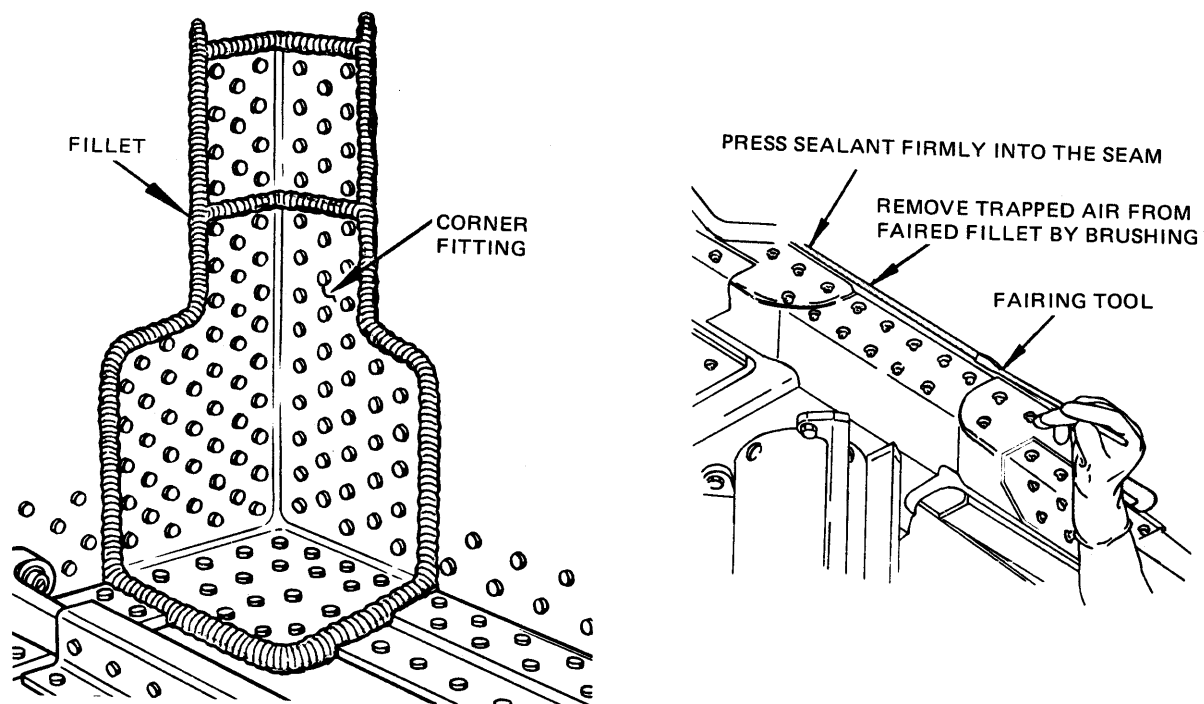
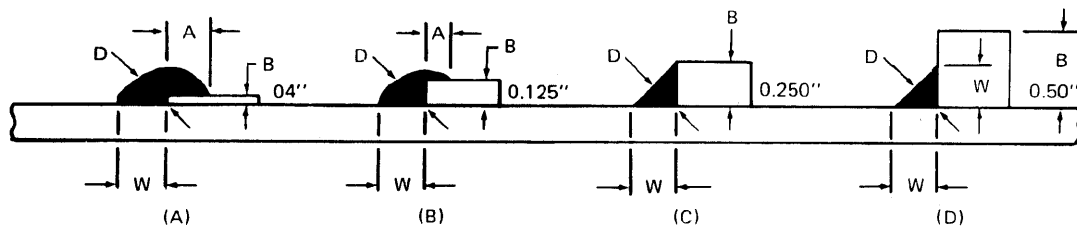
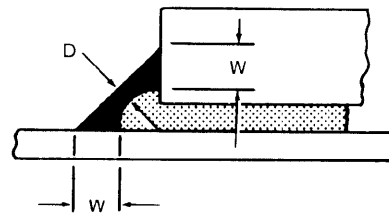
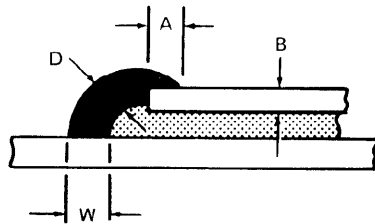


Figure 6-29. Typical Fillet Seals



$D = 0.15'' \text{ TO } 0.20''$   
 $W = 0.25'' \text{ TO } 0.37''$



$D = 0.15'' \text{ TO } 0.20''$   
 $W = 0.25'' \text{ TO } 0.37''$

**NOTE**

"A" IS DEFINED BY FORMULA  $A = B - W$ , EXCEPT A ZERO WHEN  $B = 0.25''$  OR MORE  
 CADMIUM PLATED PARTS SHOULD BE ISOLATED FROM CURING TYPE SEALANTS WITH APPROPRIATE TOPCOAT.

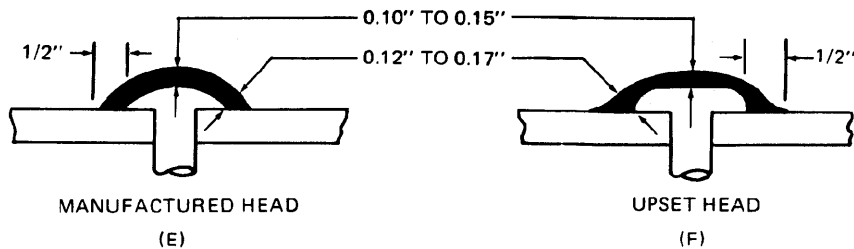
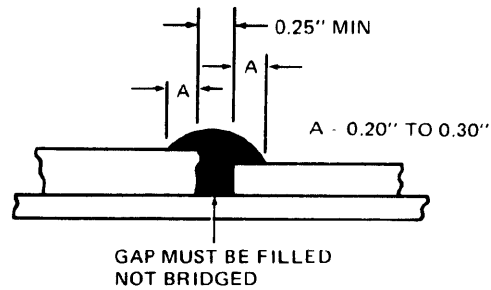
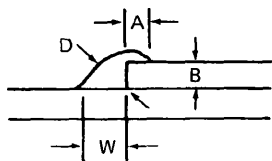


Figure 6-30. Typical Fillet Dimensions (Sheet 1 of 2)



C-140 (LOCKHEED)  
 $W = 3/16''$  TO  $1/4''$   
 $A = 1/16''$  TO  $1/8''$   
 $D = 1/8''$  MIN  
 $B = \text{LESS THAN } 1/4''$

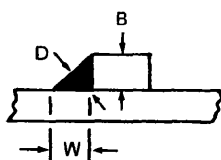
F-8 (VOUGHT)  
 $W = 0.12''$  TO  $0.25''$   
 $A = 0.06''$  TO  $0.12''$   
 $B = \text{LESS THAN } 0.15''$

C-5A (LOCKHEED)  
 $W = 1/2'' = \text{NOMINAL}$ ,  $3/8'' = \text{MIN}$   
 $A = 1/4'' = \text{NOMINAL}$ ,  $3/16'' = \text{MIN}$   
 $D = 1/4'' = \text{MAX}$   
 $B = 1/4'' = \text{MAX}$

L-1011 (LOCKHEED)  
 $W = 3/16''$  TO  $1/4''$   
 $A = 1/16''$  TO  $1/8''$   
 $D = 1/8''$  MIN  
 $B = 1/3''$  MAX

B-1 (ROCKWELL)  
 $W = 0.25''$  MIN,  $0.35''$  AVERAGE  
 $A = 0.12''$  MIN  
 $D = 0.12''$  MIN  
 $B = \text{LESS THAN } 0.15''$

DOUGLAS (ALL MODELS)  
 $W = 1/4''$  MIN  
 $A = 1/4''$  MIN



C-140 (LOCKHEED)

F-8 (VOUGHT)

$W = 3/8''$  TO  $1/2''$

$W = 0.12''$  TO  $0.25''$

$B = 1/4''$  TO  $1/2''$

$B = 0.15''$  MIN

$D = 3/16''$  MIN

C-5A (LOCKHEED)

L-1011 (LOCKHEED)

$W = 1/2'' = \text{NOMINAL}$ ,  $3/8'' = \text{MIN}$

$W = 1/4''$  TO  $3/8''$

$B = 1/4'' = \text{MIN}$

$B = 1/8''$  MIN

$D = 1/4'' = \text{MIN}$

$D = 1/8''$  MIN

DOUGLAS (ALL MODELS)

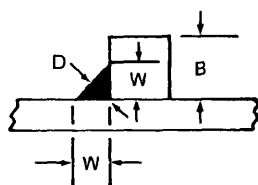
$W = 1/4''$  MIN

C-130 (LOCKHEED)

$B = 1/4''$  MIN

$W = 1/4'' = \text{MIN}$ ,  $3/8'' = \text{AVERAGE}$

$D = 1/8'' = \text{MIN}$



C-140 (LOCKHEED)

L-1011 (LOCKHEED)

$W = 3/8''$  TO  $1/2''$

$W = 1/4''$  TO  $5/8''$

$D = 3/16''$  MIN

$D = 1/8''$  MIN

C-5A (LOCKHEED)

DOUGLAS (ALL MODELS)

$W = 1/2'' = \text{NOMINAL}$ ,  $3/8'' = \text{MIN}$

$W = 1/4''$  MIN

$D = 1/4'' = \text{MIN}$

F-8 (VOUGHT)

$W = 0.12''$  TO  $0.25''$

Figure 6-30. Typical Fillet Dimensions (Sheet 2 of 2)

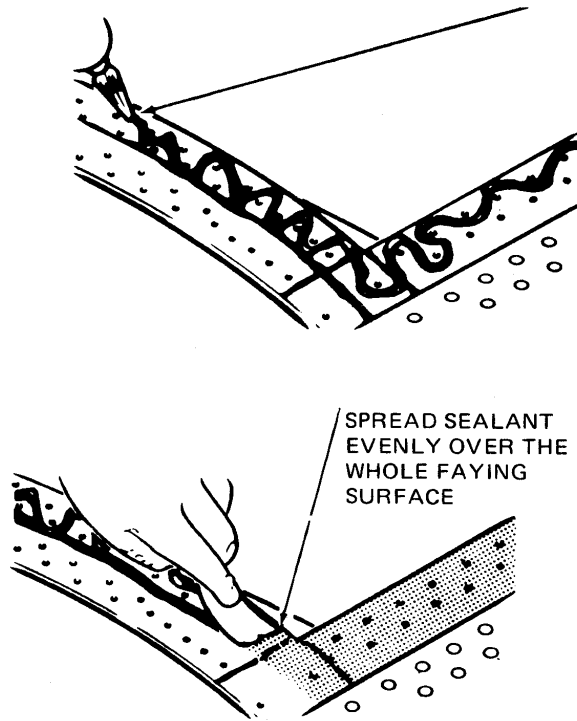


Figure 6-31. Applications of Faying Surface Sealant

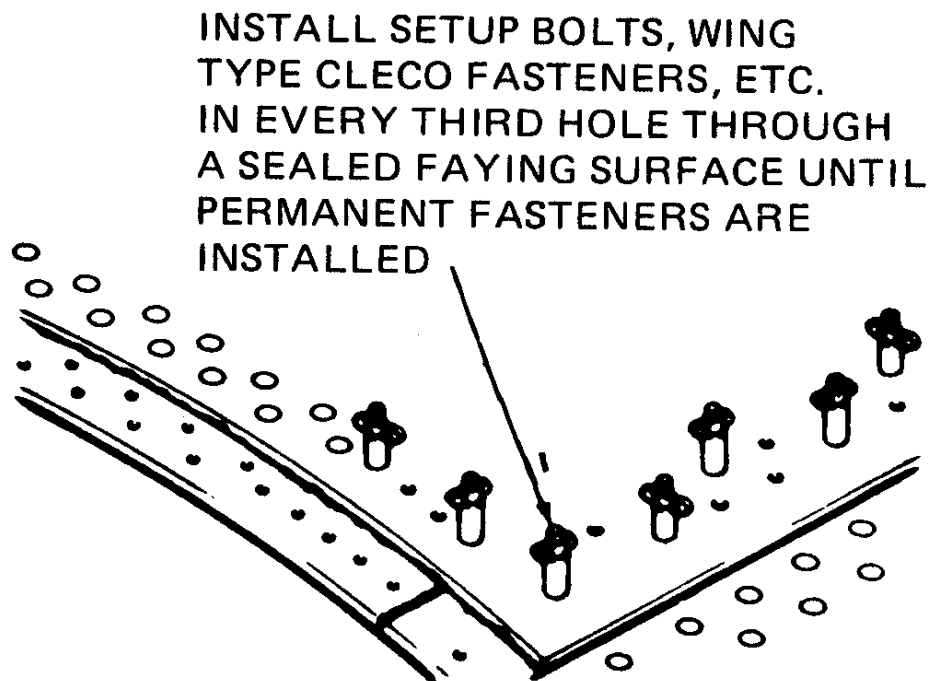


Figure 6-32. Faying Surface Seal Assembly

## SECTION VII

### FUEL CELLS

#### 7-1 PURPOSE.

This section describes fuel cells, fittings, authorized repair methods, inspections, storage, packaging and removal and installation procedures.

#### 7-2 GENERAL.

7-2.1 A fuel cell is a flexible bag contoured to the shape of a particular cavity. Cells are manufactured in three basic types, self-sealing, bladder, and combination (part bladder and part self-sealing). Fuel cell cavities shall be fuel tight. Leaks in cell cavities shall be repaired in accordance with the aircraft technical manuals or Section VI.

7-2.2 The purpose of cell repair is to return a cell to a serviceable condition, to restore its ability to carry the maximum load permitted, and to allow the cell to perform all functions for which it is designed.

#### 7-3 CELL CONSTRUCTION

##### 7-3.1 Self-Sealing Cells.

7-3.1.1 A self-sealing cell is designed to temporarily seal itself when punctured. The sealing action reduces fire hazard and minimizes fuel loss. The cell must be repaired to retain its self-sealing capability. There are four primary layers in a self-sealing cell: an inner liner of Buna-N synthetic rubber or rubber coated fabric; a nylon barrier film; semi-cured natural rubber sealant; a retainer of woven cord usually nylon, rayon or cotton. Cells may contain more than the four individual layers but the added layers will fall into one of the four general classifications. Functions for each of the four general classifications of layers are: The inner liner protects the nylon barrier; the nylon barrier contains the fuel and prevents diffusion through the cell wall; the sealant remains dormant until contacted by fuel, when contacted by fuel the sealant swells and closes the opening; the fabric material strengthens the cell and protects the nylon barrier.

7-3.1.2 The standard and lightweight construction are shown in figure 7-3. In this construction the inner liner is made of nylon. The sealant is placed on the cell in two layers, a layer or layers of cord fabric placed between the two layers of sealant, a layer or layers of cord fabric placed on the exterior of the cell, and an outside lacquer coating which must remain fuel resistant for 72 hours.

7-3.1.3 The sealing function is brought about by a chemical and mechanical reaction which takes place when the cell is punctured. The mechanical reaction is the result of the property of the rubber to give under impact thereby limiting the damage to a small hole. The chemical reaction results in the swelling of the rubber material when in contact with fuel.

##### 7-3.2 Bladder Cells.

7-3.2.1 The four basic types of bladder cells are: those constructed of two or more plies of rubber coated fabric; those constructed of a combination of rubber coated fabric and Buna-N gum; those constructed of all nylon fabric and those constructed of polyurethane coated nylon fabric over a polyurethane sprayed inner liner. Bladder cells are lightweight and are not selfsealing. There are three primary layers in a bladder cell: an inner liner of Buna-N synthetic rubber or rubber coated fabric; a nylon barrier film; a retainer of woven cord usually nylon, rayon or cotton. Cells may contain more than the three individual layers but the added layers will fall into one of the three general classifications. Functions for each of the three general classifications of layers are: The inner liner protects the nylon barrier; the nylon barrier contains the fuel and prevents diffusion through the cell wall; the fabric material strengthens the cell and protects the nylon barrier.

7-3.3 Combination Cells. These cells consist of bladder and self-sealing cell construction. Most are usually self-sealing on the bottom and aft sections only.

7-3.4 Fittings. There are three general types of fittings used on fuel cells:

7-3.4.1 Rubber Face. This fitting has a ring of metal molded into the opening. It may be fully molded rubber or combined rubber and fabric. A seal is made by compression of the rubber faces between the cell and its mating part.

7-3.4.2 Compression. This fitting is used on bladder cells and consist of two metal rings. The cell openings are bolted between the rings to create a seal.

7-3.4.3 Metal-to-Metal. This fitting consist of a metal ring molded into the cell opening, which leaves the seal side of the metal ring exposed. A seal is made by using O-rings between the metal surfaces of the cell fitting and its mating part.

## 7-4 FUEL CELL HANDLING

### 7-4.1 GENERAL

7-4.1.1 Fuel cells are subject to various kinds of damage during normal handling. Care shall be taken when handling cells as they are easily damaged during uncrating, preparation for installation, during installation, removal from aircraft, and packing. All work surfaces used for fuel cell repair shall be clean, smooth, and padded. Cell handling should be kept to a minimum to avoid damaging the cell.

7-4.1.2 Never lift, move, or carry a cell by its fittings. Using fittings as lifting or handling points can damage the fittings.

7-4.1.3 Do not unnecessarily collapse or fold a cell as this may damage the nylon liner.

7-4.1.4 Do not drag or tumble a cell as this could damage the cell exterior.

7-4.1.5 Make sure work areas are clear of foreign objects which could damage the cell.

7-4.1.6 Use care when uncrating and crating cells to avoid damaging the cells.

7-4.2 Bladder Cell Handling. Bladder cells and beaded fitting cells are collapsed and folded prior to being placed in shipping and storage containers. Additional protection is provided beaded fitting cells by the installation of a split hose over the bead and by collapsing the cell over a fiberboard tube with a minimum diameter of six inches. The following precautions shall be followed when folding and unfolding bladder cells:

7-4.2.1 Never fold or unfold a cell if its temperature is below 65°F. Use an approved heater to heat the cell and cell cavity. The optimum folding temperature for a cell is 70°F.

7-4.2.2 Always fold and unfold cells on clean, smooth, padded surfaces that are covered with canvas and waxed paper or rubberized fabric.

7-4.2.3 New cells that are boxed or crated and stored for more than a year may shrink. These cells should be soaked in warm water, not to exceed 120°F, prior to air testing and installation.

7-4.2.4 Do not fold cells abusively or by air evacuation.

7-4.2.5 Install cell fitting protector rings as required by the aircraft technical manuals. Install protector rings prior to clamping the cell.

7-4.2.6 Do not rest cell on sharp objects, table edges, table corners or cavity edges.

7-4.2.7 Do not place heavy objects on cells.

7-4.2.8 Place protective caps on metal fittings that extend from the cell, when cell is out of cavity.

7-4.3 Self-Sealing Cell Handling. The following precautions shall be followed when folding and unfolding self-sealing cells:

7-4.3.1 Never fold or unfold a cell if its temperature is below 65°F. Use an approved heater to heat the cell and cell cavity. The optimum temperature is for folding a cell is 70°F.

7-4.3.2 Always fold and unfold cells on clean, smooth, padded surfaces that are covered with canvas and waxed paper or rubberized fabric. One hour is the maximum time permitted for a cell to remain collapsed or folded. Collapse or fold just prior to installation or removal.

7-4.3.3 Do not fold cells abusively or by air evacuation.

7-4.3.4 Install cell fitting protector rings as required by the aircraft technical manuals. Install protector rings prior to clamping the cell.

7-4.3.5 Do not rest cell on sharp objects, table edges, table corners or cavity edges.

7-4.3.6 Do not place heavy objects on cells

7-4.3.7 Place protective caps on metal fittings that extend from the cell, when cell is out of cavity.

7-4.3.8 Self-sealing cells are not collapsed for shipping or storage. They are shipped in their normal configuration.

7-4.3.9 Cells which have been improperly collapsed, stored or have for some other reason taken on a permanent crease may be salvaged by placing the cell in an air circulating oven set to 150°F. Pour warm water, not to exceed 120°F, over the outside and inside of cell. The heat and moisture will soften the rubber and allow movement without damaging the nylon barrier. After one hour gradually stretch the cell and install internal supports. When the cell is restored to its normal shape allow the soak to continue for a total of four hours at 150°F. Remove the cell from the oven and air soak at room temperature for 20 hours before air testing and inspection.

### 7-4.4 CELL REMOVAL

7-4.4.1 Purge, drain, remove foam and depuddle cell in accordance with Section V.

7-4.4.2 Make sure the cell and cavity are 65°F. The optimum temperature is 70°F. Use an approved heater as necessary.

7-4.4.3 Remove cells in order beginning with Cell #1 or individually as required.

7-4.4.4 Disconnect all lines and fittings. Place all manifolds, hardware, components, etc., in a clean, dry area. Cap lines and components as necessary. Mark and inspect components as necessary.

7-4.4.5 Untie and remove all lacing and disconnect all hangers or retainer rods.

7-4.4.6 Fold cell in accordance with aircraft technical manual and paragraph 7-4.

7-4.4.7 Carefully remove cell from cavity. Do not force cell from cavity. If cell hangs up recheck to ensure fittings, hangars, and etc., have been removed.

## 7-5 FUEL CELL PRESERVATION, PACKING AND STORAGE

### 7-5.1 CELL PRESERVATION

7-5.1.1 Vithane and Other Polyurethane Self-Sealing and Bladder Cells. Clean the interior and exterior of the cell with soap, (commercial, liquid non-abrasive dish or laundry soap/detergent.), and warm water. Rinse with clear, warm water.

7-5.1.2 Rubber or Synthetic Rubber Self-Sealing and Bladder Cells. Fuel has the tendency to extract the plasticizer from the rubber inner liner of a fuel cell. The loss of plasticizer is not detrimental to a cell as long as fuel remains in the cell. When fuel is drained from the cell the cell will dry and cracking or checking can occur. To prevent this type of failure apply a thin coating of a mixture containing 80 percent JP-5 and 20 percent oil, MIL-L-6081 Grade 1010, or VV-L-825, to the interior of the cell. If the cell is to be packaged and turned into supply or remain uninstalled for more than 72 hours apply a thin coat of 100 percent oil, MIL-L-6081 Grade 1010, or VV-L-825 in accordance with TO 00-85A-03-1. Oil may be applied by wiping or fogging. Excess oil shall be wiped-up with cheesecloth.

### 7-5.2 CELL PACKAGING

7-5.2.1 Short-Term Storage (Less than 60 Days). Cover all openings and fittings with cushioning material specification, A-A-549, or barrier material MIL-B-121, Grade A, and secure with tape, MIL-T-22085, Type II. Wrap the cell in cushioning material or barrier material and place in a suitable container to prevent damage.

7-5.2.2 Long-Term Storage or Return to Supply. Package all cells in accordance with TO 00-85A-03-1.

7-5.3 STORAGE. All packaged cells should be stored in a dry area, protected from direct sunlight.

7-5.4 PERIODIC INSPECTIONS. Fuel cells are an assembly of items made from age sensitive elastomers which are subject to deterioration by oxygen, ozone, sunlight, heat, rain, and similar other factors experienced in normal storage or use. Cells taken from storage should be thoroughly inspected prior to installation in the aircraft. All vithane cells in storage should be reinspected at two year intervals. If cells are installed in the aircraft they should be thoroughly inspected during depot maintenance.

### 7-6 FUEL CELL INSPECTION.

7-6.1 Inspection procedures are to establish uniform inspection procedures for cells and fittings. These standards shall be used by all personnel engaged in inspecting fuel, oil, and water-alcohol cells. When possible cells and self-sealing surfaces should be inspected prior to removal to eliminate unnecessary removals and handling. Serviceable cells should be stenciled with the word "SERVICEABLE", inspecting organization's symbol, and date. The AFTO 95 shall be annotated as necessary.

7-6.2 Diagnostic Information. The following information can help prevent incorrect diagnosis of fuel cell leakage.

7-6.2.1 Investigation of reports, stating that fuel was seeping through a cell because of pinholes or porous liners, revealed the cell was often good, but was saturated with fuel trapped in the cavity. No cell is intended to be completely impervious to fuel from the outside. When fuel is trapped in the cavity some of the fuel will be absorbed by the outer ply of fabric.

7-6.2.2 JP fuels will not evaporate as readily as aviation gasoline. Cell fabric will stay wet for several days. This often causes persons unfamiliar with bladder cell construction to diagnose the condition as fuel seepage. The area may appear dry and when pressurized or tested with fuel will appear to seep. This condition is caused by the internal pressure on the fabric which causes the fuel to ooze to the surface. This condition is called weeping and is not an indication of a leaky cell.

7-6.2.3 Pinholes are sometimes found to be caused by minute imperfections or foreign matter in the cell inner liner. In the coating process: the rubber may not be perfectly smooth; small particles may be embedded in the rubber; or there may be small indentations in the rubber from imperfection in the mold. This may be acceptable if the nylon barrier is not broken.

7-6.2.4 A condition often reported in new cells is delamination. Acceptance standards allow a certain amount of loose liner lap, channel and blistering. Test and service experience prove that these

conditions will not affect serviceability if the allowable limits are not exceeded.

7-6.2.5 New cells have been reported as having ozone checked liners. Conditions which make the liners in new cells look deteriorated are almost always minor manufacturing imperfections caused by crazing or cracking of the coating used on the building forms. The outline of the crazing on the molds is easily transferred to the rubber material of the cell.

7-6.2.6 Fried or scarred inner liners are usually found in cells with gum liners. This condition is caused by small amount of air or solvent vapor being trapped between the liner and the building form. This air or vapor cannot escape due to the pressures applied during manufacturing and causes depressed areas to be formed on the soft inner liner. This condition will not progress after the manufacturing process is complete.

7-6.2.7 Self-supporting, non-metallic fuel cells frequently are found with separation between the self-sealing portion and the hard outer shell. The basic design of principal of these cells is for the cell to delaminate easily around the area of bullet entry. To make sure of this delamination, the cement used between the cell and the shell does not afford permanent adhesion. These separations may be ignored if the delaminations do not substantially affect cell capacity.

7-6.2.8 Activation of self-sealing cells may be from either internal or external fuel. Proper evaluation of the cell is required to determine if a pin-hole, wicking or external fuel contact has caused the activation.

7-6.2.9 Fuel bubbles that accumulate between the interior surface of the fuel cell and the supplementary metallic supports should not be considered defects provided the structure of the fuel cell remains unbroken.

#### 7-6.3 Cleaning Prior to Inspection.

7-6.3.1 Materials Required. Clean static free absorbent wiping cloths, solvent (P-D-680, Type II or Type III), liquid soap (commercial, liquid, non-abrasive dish or laundry soap/detergent.), hot water (not to exceed 120°F).

7-6.3.2 Prior to inspection fuel cells shall be cleaned as required using cloth and cleaning solvent. Soap and hot water, not to exceed 120°F, may be used for large scale cleaning. All soap residue shall be removed with clear water. Cells shall be dried thoroughly after cleaning.

7-6.3.3 Self-Sealing Cell Drying. Self-sealing cells shall be drained and thoroughly dried as soon as possible after damage is found to prevent excessive activation of the sealant. Drying may be

accelerated by placing the cell in a warm area (80°F) and flowing air through the cell. Higher temperatures will dry the fuel soaked sealant nearest the damage and trap fuel in the sealant. Trapped fuel will cause separation and breakdown of the sealant area. To prevent this condition, the edge of the damage shall be spread slightly with wood peg to allow fuel vapors to escape from the sealant. This type of damage requires several days to properly dry.

#### 7-6.4 Inspection Procedures and Criteria.

7-6.4.1 Characteristics have been classified according to their relative importance to cell serviceability. Fuel cell inspectors must rely on visual inspection and knowledge of fuel cell construction. Stand testing with fuel is the most positive method of testing self-sealing cells and should be accomplished if possible.

7-6.4.2 Prior to installation in the aircraft inspect the cell in accordance with paragraph 7-6.5. Cells installed in the aircraft shall be inspected in accordance with paragraph 7-6.6. The criteria for self-sealing and bladder cell shall be used when inspecting multiplex, self-sealing, and combination cells.

7-6.4.3 Cells not meeting the inspection criteria shall be repaired to acceptable limits or returned to supply as repairable items. Condemnation of fuel cells shall be determined by an ALC fuel cell repair shop.

#### 7-6.5 INSPECTION OF NEW AND REMOVED SELF-SEALING CELLS.

##### 7-6.5.1 SELF-SEALING CELL INTERIOR INSPECTION.

- a. Loose Liner at Throat of Fitting. 1/2-inch looseness in width around circumference at throat of fitting (figure 7-5). Looseness to be trimmed at time of repair up to 1/4-inch width if 1-inch bond is maintained between laps. Vertical edge looseness is acceptable.
- b. Edge Looseness at Liner Lap. 1/4-inch width if 1-inch bond is maintained between laps.
- c. Edge Looseness on Liner Reinforcements. Corner Patches and Chaffing Patches. 1/2-inch maximum looseness if loose area does not exceed 15 percent of patch width. Blisters or separations other than in edge area allowable up to 1/2-inch square, six inches apart.
- d. Looseness Under Cemented Components such as Attaching straps, Baffle Shoes, etc. 15 percent of individual areas if 1/2-inch

bond is maintained around edge (figure 7-6).

- e. Blisters Between Liner and Fitting Flange. 1/2-inch maximum dimension; maximum one per liner foot and four per fitting if one-inch bond is maintained (figure 7-5).
- f. Damaged Grommets in Accessories. Acceptable if serviceability is not affected. Shall be repaired at time of other repair.
- g. Damaged Coating on Accessories (Metal or Rubber). Acceptable if corrosion or other deterioration is not present. Corrosion treatment shall be accomplished in accordance with TO 1-1-691.
- h. Checking Due to Weather, Ozone, Dry Cracking, or Surface Imperfections in Liner (figure 7-9). Not acceptable.
- i. Blisters in Liner Lap. 1/4-inch maximum dimension; no more than one per liner foot of splice with maximum of five in any five-foot length of splice (figure 7-7).
- j. Blisters, Delaminations or Ply Separations. 1-inch square maximum dimension if there is a 6-inch bond between blisters.
- k. Channels in Inner Liner Laps. 1/4-inch by three-inch maximum dimension with a maximum of one in any five lineal foot of splice (figure 7-7).
- l. Channels Around Entire Outer Edge of Fitting Flange. 1/4-inch maximum width (figure 7-5).
- m. Channels at Tapered Construction Step-Off Area or Edge of Lap Splices of any Ply. 1/4-inch maximum width of entire length of lap (figure 7-8).
- n. Open End Channels in Three-Ply Liner Overlaps or Tailored Corners. 1/4-inch by three-inch maximum dimension if one-inch minimum bond is maintained between end of channel and sealant.
- o. Cuts or Tears in Inner-Liner. Not acceptable.
- p. Buffing Through Inner-Liner. Not acceptable.

#### 7-6.5.2 SELF-SEALING CELL EXTERIOR INSPECTION.

- a. Blisters or Ply Separation Between any Plies Except Liner and Sealant. One-inch maximum dimension.
- b. Skim Coat Paint Blister. Acceptable.

- c. Loose Hangar Straps or Hangar Attaching Points. Acceptable up to 15 percent looseness total area if 1/4-inch bond is maintained around edge.
- d. Checking due to Weather, Ozone, Dry Cracking, or Surface Imperfections other than Fittings. Acceptable.
- e. Damaged Grommets in Accessories. Acceptable if serviceability is not affected, but repair shall be made at time of other repair.
- f. Damage Through Outer Cord or Fabric Ply. Not acceptable.
- g. Channels or Bridging of Outer Plies at Cord or Fabric Splices. 1/2-inch maximum width, full length of splice (figure 7-8).
- h. Outer Ply Cuts or Splits Parallel to Cords Where Cords are not Damaged. Not acceptable, may cause activation.
- i. Permanent Set or Crease. Not Acceptable.
- j. Loose Liner at Throat of Fitting. One-inch looseness in width around circumference at throat of fitting (figure 7-5). Looseness to be trimmed at time of other repair up to 1/4-inch width if one-inch bond is maintained between laps. Vertical edge looseness is acceptable.

#### 7-6.5.3 FULLY RUBBER-MOLDED FITTINGS INSPECTION.

- a. Gouges, Splits, or Deep Indentations on Sealing Surface. 1/16-inch maximum depth by 1/16 inch maximum length (figure 7-11).
- b. Weather Checking on Sealing Surface. Not acceptable (figure 7-11).
- c. Weather Checking on Outer Flange. Acceptable up to a depth of 1/16-inch depth.

#### 7-6.5.4 SEALING FACE WITHOUT O-RING GROOVE.

- a. Burrs on Mating Surface. Not Acceptable.
- b. Corrosion. Not acceptable.
- c. Weather Checking on Outer Flange. Acceptable.

#### 7-6.5.5 SEALING FACE WITH O-RING GROOVE.

- a. Minor Surface Damage Outside O-Ring Groove other than Corrosion or Burrs. Acceptable.
- b. Physical Damage to O-Ring Groove. Not acceptable.

- c. Corrosion. Not acceptable.
- d. Cement or other Foreign Material in O-Ring groove. Not acceptable.
- e. Bent or Broken Fittings. Not acceptable.
- f. Thread-Damaged Fittings. Not acceptable.

#### 7-6.6 INSPECTION OF NEW AND REMOVED BLADDER-TYPE CELLS.

##### 7-6.6.1 BLADDER CELL INTERIOR INSPECTION.

- a. Loose Liner at Throat of Fitting. 1/2-inch looseness in width around circumference at throat of fitting, except Firestone construction on which 1/16-inch edge looseness is allowable (figure 7-5). Vertical edge looseness is acceptable.
- b. Edge Looseness at Liner Lap. 1/4-inch width if one-inch bond is maintained between laps, except Firestone construction 1052-6 on which 1/16-inch edge looseness is acceptable (T-33 aircraft only).
- c. Edge Looseness on Liner Reinforcements. Corner Patches and Chaffing Patches. 1/2-inch maximum looseness if loose area does not exceed 15 percent of patch total area. Blisters or separations other than in edge area allowable up to 15 percent of total area.
- d. Looseness Under Cemented Components such as Attaching straps, Baffle Shoes, etc. 15 percent of individual areas if 1/4-inch bond is maintained around edge.
- e. Blisters Between Fitting Flange and Adjacent Ply. 1/2-inch maximum dimension; maximum two per lineal foot and two per fitting if one-inch bond is maintained (figure 7-5).
- f. Damaged Grommets in Accessories. Acceptable if serviceability is not affected. Shall be repaired at time of other repair.
- g. Damaged Coating on Accessories (Metal, Rubber or Wood). Acceptable if corrosion or other deterioration is not present. Corrosion treatment shall be accomplished in accordance with TO 1-1-691.
- h. Checking Due to Ozone of Buna Rubber (figure 7-9). Not acceptable.
- i. Channels Between Liner Laps. one-inch width by one-inch length maximum dimension; one per liner foot with a maximum of five in any eight-foot length of splice (figure 7-7).

- j. Blisters Between Plies. One-inch maximum dimension; minimum three-inch bond between blisters, maximum one/foot square.
- k. Channels in Liner Laps. 1/4-inch by three-inch maximum dimension with a maximum of one in any five liner foot of splice (figure 7-7).
- l. Weather Checking on Fabric. Not acceptable.
- m. Channels Around Entire Outer Edge of Fitting Flange. 1/4-inch maximum width around fitting flange (figure 7-5).
- n. Buffing Through Inner-Liner. Not acceptable.
- o. Exposed Fabric. Acceptable if exposed fabric has no damaged cords.
- p. Delamination Between Plies. One-inch maximum dimension; one per five square foot of area, minimum six-inch solid bond between delaminations.
- q. Cuts, Holes, or Tears in Inner-Liner. Not acceptable.

##### 7-6.6.2 BLADDER CELL EXTERIOR INSPECTION.

- a. Skim Coat Blisters. Acceptable.
- b. Lap Splice Edge Looseness. 1/4-inch by three-inch maximum dimension with no more than one per linear foot if one-inch bond is maintained.
- c. Loose or Damaged Hangar Straps or Hangar Attaching Points, acceptable up to 15 percent of component area if 1/4-inch solid bond is maintained around edge (figure 7-12).
- d. Loose Tapes, Corner Patches or Outside Non-Load Carrying Accessories. 1/2-inch maximum allowable looseness if it does not exceed 25 percent of total area.
- e. Skim Coat Off Outer Ply. Acceptable if cords or fabric are not cut or broken.
- f. Mislocated, Blistered, Split, or Weather Checked Tape. Acceptable; mission tape to be replaced.
- g. Blisters or Looseness Between labels or Decals and Body of Cell. Acceptable.
- h. Weather Checked or Surface Imperfections in Outer Ply or Reinforcements. Acceptable if fabric not damaged or broken.

- i. Blistered, Loose or Missing Lacquer Coating. Acceptable
- j. Blisters Between fitting Flange and Adjacent Ply. 1/2-inch maximum dimension; maximum of two per linear foot and two per fitting if one-inch bond is maintained (figure 7-5).
- k. Delamination Between Plies. One-inch maximum dimension; one per five square feet of area in any five-foot area; minimum six-inch solid bond between delaminations.
- l. Damaged Grommets in Accessories, acceptable if serviceability is not affected.
- m. Blisters Between Outer Ply Laps. 1/2-inch width by one-inch length maximum dimension; one per five linear feet of splice with a maximum of five in any five-foot length of splice.
- n. Blisters Between Plies (In Cell Panels). 1/2-inch maximum dimension; minimum of six-inch bond between blisters and no more than one per square foot of cell area.
- o. Channels in outer ply laps. 1/4-inch width entire length of lap.
- p. Looseness Around Outer Fitting Flange. 1/4-inch maximum around fitting Range (figure 7-5) if one-inch bond is maintained. Vertical edge looseness is acceptable.
- q. Damage Through any Cord or Fabric Ply. Not acceptable.
- r. Holes in Inner Liner. Not acceptable; confirm by pressure test.

#### 7-6.6.3 RUBBER FACE FITTINGS.

- a. Gouges, Splits, or Indentations on Sealing Surface. 1/16-inch depth by 1/16-inch length maximum dimension.
- b. Weather, Ozone Checking of Surfaces Other than Sealing Surface. Acceptable.
- c. Weather, Ozone Checking of Sealing Surface. Not acceptable.

#### 7-6.6.4 SEALING SURFACE WITHOUT O-RING GROOVE.

- a. Scratches Within Sealing Area. Not acceptable (figure 7-11).
- b. Burrs on Mating Surfaces. Not acceptable (figure 7-11).
- c. Corrosion or Rust. Not acceptable.

#### 7-6.6.5 SEALING SURFACE WITH O-RING GROOVE.

- a. Minor Surface Damage Outside O-Ring Groove other than Corrosion or Burrs. Acceptable.
- b. Physical Damage to O-Ring Groove. Not acceptable.
- c. Corrosion. Not acceptable.
- d. Cement or other Foreign Material in O-Ring groove. Not acceptable.
- e. Bent or Broken Fittings or Damaged Dome Nuts. Not acceptable.
- f. Elongated or Torn Holes in Fitting Flange of Cells Using U.S. Rubber Removable Two-Piece Metal Compression Fittings. Acceptable if elongation or tear does not extend beyond outer or inner sealing groove of inner ring or over 1/2 the distance to the next hole; minimum of two holes in a row with these conditions.
- g. Thread-Damaged Fittings. Not acceptable.

#### 7-6.7 INSPECTION OF INSTALLED SELF-SEALING CELLS.

##### 7-6.7.1 SELF-SEALING CELL INTERIOR INSPECTION.

- a. Loose Collar at Throat of Fitting. One-inch looseness in width around circumference at throat of fitting does not include the collar on a replaced fitting (figure 7-5).
- b. Edge Looseness at Liner Lap. 1/2-inch width if remainder of bond is good (figure 7-7).
- c. Edge Looseness on Liner Reinforcements. Corner Patches and Chaffing Patches. 1/2-inch maximum looseness if loose area does not exceed 20 percent of total area. Blisters or separations other than in edge area allowable up to 20 percent of total area.
- d. Looseness Under Cemented Components such as Attaching straps, Baffle Shoes, etc. 20 percent of individual areas if 1/4-inch bond is maintained around edge (figure 7-6).
- e. Blisters Between Liner and Fitting Flange. 1/2-inch maximum dimension; maximum two per liner foot and three/fitting if one-inch bond is maintained (figure 7-5).
- f. Damaged Grommets in Accessories. Acceptable if serviceability is not affected. Shall be repaired at time of other repair.
- g. Damaged Coating on Accessories (Metal or Rubber). Acceptable if corrosion or other deterioration is not present. Corrosion

treatment shall be accomplished in accordance with TO 1-1-691.

- h. Checking Due to Weather, Ozone, Dry Cracking, or Surface Imperfections in Liner (figure 7-9). Not acceptable.
- i. Blisters in Liner Lap 1/2 inch maximum dimension; with maximum of five in any five-foot length of splice with a minimum six-inch bond between blisters (figure 7-9).
- j. Blisters, Delaminations or Ply Separations 1 1/2-inch maximum dimension if there is a six-inch bond between blisters and not more than one per square foot of area.
- k. Channels in Inner Liner Laps. 1/4-inch by three-inch maximum dimension with a maximum of one in any five-lineal foot of splice (figure 7-7).
- l. Channels Around Entire Outer Edge of Fitting Flange. 1/2-inch maximum width (figure 7-5).
- m. Channels at Tapered Construction Step-Off Area or Edge of Lap Splices of any Ply. 1/2 inch maximum width of entire length of lap (figure 7-8).
- n. Open End Channels in Three-Ply Liner Overlaps or Tailored Corners. 1/4-inch by three-inch maximum dimension if one-inch minimum bond is maintained between end of channel and sealant (figure 7-7).
- o. Cuts or Tears in Inner-Liner. Not acceptable
- p. Buffing Through Inner-Liner. Not acceptable
- q. Damaged Anchor Fittings. Maximum cut or worn area 25 percent of total dimension.
- r. Activated Area. Not Acceptable.
- s. Broken Stiffeners or Supports. Not acceptable.

#### 7-6.7.2 SELF-SEALING CELL EXTERIOR INSPECTION.

- a. Only accessible portions of cells will be inspected. Do not remove cells from aircraft for inspection.
- b. Blisters or Ply Separation Between any Plies Except Liner and Sealant. 1 1/2-inch maximum dimension.
- c. Skim Coat Paint Blister. Acceptable.

- d. Loose Hangar Straps or Hangar Attaching Points. Acceptable up to 20 percent looseness total area if 1/4-inch bond is maintained around edge.
- e. Loose or Damaged Tapes, Corner Patches or Other Outside Accessories. Acceptable if sealant is not activated.
- f. Checking due to Weather, Ozone, Dry Cracking, or Surface Imperfections other than Fittings. Acceptable.
- g. Damaged Grommets in Accessories. Acceptable if serviceability is not affected, but repair shall be made at time of other repair.
- h. Damage Through Outer Cord or Fabric Ply. One-inch maximum dimension.
- i. Channels or Bridging of Outer Plies at Cord or Fabric Splices. 1/2-inch maximum width, full length of splice (figure 7-10).
- j. Outer Ply Cuts or Splits Parallel to Cords Where Cords are not Damaged. Acceptable if sealant is not activated.

#### 7-6.7.3 FULLY RUBBER-MOLDED FITTINGS INSPECTION.

- a. Gouges, Splits, or Deep Indentations on Sealing Surface. 1/16-inch maximum depth by 1/8 inch maximum length (figure 7-11).
- b. Weather Checking on Sealing Surface. Acceptable (figure 7-11).

#### 7-6.7.4 SEALING FACE WITHOUT O-RING GROOVE.

- a. Scratches Within Sealing Area. Not acceptable (figure 7-11).
- b. Burrs on Mating Surface. Not Acceptable.
- c. Damage to Protective Coating. Acceptable.
- d. Corrosion. Not acceptable.

#### 7-6.7.5 SEALING FACE WITH O-RING GROOVE.

- a. Minor Surface Damage Outside O-Ring Groove other than Corrosion or Burrs. Acceptable.
- b. Physical Damage to O-Ring Groove. Not acceptable.
- c. Corrosion. Not acceptable.
- d. Cement or other Foreign Material in O-Ring groove. Not acceptable.
- e. Bent or Broken Fittings. Not acceptable.
- f. Thread-Damaged Fittings. Not acceptable.

## 7-6.8 INSPECTION OF INSTALLED BLADDER-TYPE CELLS.

### 7-6.8.1 BLADDER CELL INTERIOR INSPECTION.

- a. Loose Liner at Throat of Fitting Except Sump-Type and Three-Plane Fittings. 1/2-inch looseness in width around circumference at throat of fitting, except Firestone construction on which 1/16-inch edge looseness is allowable if one-inch bond is maintained. (figure 7-5). Vertical edge looseness is acceptable.
- b. Loose Collar at Throat of Sump-Type and Three-Plane Fittings. 1/4-inch maximum looseness (figure 7-13 and 7-14).
- c. Edge Looseness at Liner Lap. 1/4-inch width if one-inch bond is maintained between laps, except Firestone construction 1052-6 on which 1/16-inch edge looseness is acceptable (T-33 aircraft only).
- d. Edge Looseness on Liner Reinforcements. Corner Patches and Chaffing Patches. 1/2-inch maximum looseness if loose area does not exceed 25 percent of patch total area. Blisters or separations other than in edge area allowable up to 25 percent of total area.
- e. Looseness Under Cemented Components such as Attaching straps, Baffle Shoes, etc. 25 percent of individual areas if 1/4-inch bond is maintained around edge.
- f. Blisters Between Liner and Adjacent Ply. 1/2-inch maximum dimension; maximum two per liner foot and three per fitting if one-inch bond is maintained (figure 7-5).
- g. Damaged Grommets in Accessories. Acceptable if serviceability is not affected. Shall be repaired at time of other repair.
- h. Damaged Coating on Accessories (Metal, Rubber or Wood). Acceptable if corrosion or other deterioration is not present. Corrosion treatment shall be accomplished in accordance with TO 1-1-691.
- i. Weather Checking. Not acceptable.
- j. Blisters Between Liner Laps. 1/2-inch maximum dimension; maximum of five in any five-foot length of splice with a minimum of six-inch bond between blisters (figure 7-7).
- k. Blisters Between Plies. 1 1/2-inch maximum dimension; minimum six-inch bond between blisters, maximum one per square foot of cell area.

- l. Channels in Liner Laps. 1/4-inch by three-inch maximum dimension with a maximum of one in any five-linear foot of splice (figure 7-5).
- m. Channels Around Entire Outer Edge of Fitting Flange. 1/4-inch maximum width around fitting Flange (figure 7-5).
- n. Damaged Coating on Accessories (Rubber, Metal, or Wood). Acceptable if corrosion is not present.
- o. Exposed Fabric. Acceptable if exposed fabric has no damaged cords.
- p. Split or Damaged Corner Reinforcements. Acceptable.
- q. Cuts, Holes, or Tears in Inner-Liner. Not acceptable.
- r. Delamination Between Plies. 1 1/2-inch maximum dimension; one per five square foot of area, minimum six-inch solid bond between delaminations.
- s. Broken Stiffeners or Supports. Not Acceptable.

### 7-6.8.2 INSTALLED BLADDER CELL EXTERIOR INSPECTION.

- a. Only accessible portions of cells will be inspected; they shall not be removed from the aircraft for inspection.
- b. Skim Coat Blisters. Acceptable.
- c. Loose or Damaged Hangar Straps or Hangar Attaching Points, acceptable up to 25 percent of component area if 1/4-inch solid bond is maintained around edge (figure 7-12).
- d. Loose Tapes, Corner Patches or Outside Non-Load Carrying Accessories. 1/2-inch maximum allowable looseness if it does not exceed 20 percent of total area.
- e. Lap splice Edge Looseness. 3/8-inch by three-inch maximum dimension, no more than five per linear foot.
- f. Skim Coat Off Outer Ply. Acceptable if cords or fabric are not cut or broken.
- g. Mislocated, Blistered, Split, or Weather Checked Tape. Acceptable.
- h. Blisters or Looseness Between labels or Decals and Body of Cell. Acceptable.
- i. Weather Checked or Surface Imperfections in Outer Ply or Reinforcements. Acceptable if fabric not damaged or broken.

- j. Blistered, Loose or Missing Lacquer Coating. Acceptable.
- k. Damaged Grommets in Accessories. Acceptable if serviceability is not affected.
- l. Damage Through any Cord or Fabric Ply. Not acceptable.
- m. Delamination Between Plies. 1 1/2-inch maximum dimension; one per five square feet of area in any five-foot area; minimum six-inch solid bond between delaminations.
- n. Blisters Between Fitting Flange and Adjacent Ply. 1/2-inch maximum dimension; maximum of two per linear foot and three per fitting if one-inch bond is maintained (figure 7-5).
- o. Blisters Between Outer Ply Laps. 1 1/2-inch maximum dimension; two per linear feet of splice with a maximum of five in any five-foot length of splice.
- p. Blisters Between Plies (In Cell Panels). 1 1/2-inch maximum dimension; minimum of six-inch bond between blisters and no more than one per square foot of cell area.
- q. Channels in Outer Ply Laps. 1/2 entire length of lap if one-inch bond is maintained on outer edge.
- r. Channels Around Entire Edge of Fitting Flange. 1/4-inch maximum width around fitting flange (figure 7-5).

7-6.8.3 VITHANE CELL EXTERIOR INSPECTION (INSTALLED CELLS). Only accessible portions of cells will be inspected; they shall not be removed from the aircraft for inspection.

- a. Skim Coat Blisters. Acceptable.
- b. Separation Between Layers. 1/2-inch maximum dimension.
- c. Slits, Holes, or Tears. Not Acceptable.
- d. Damage Through cord or Fabric Ply. Not Acceptable.
- e. Blisters or Looseness Between any Labels or Decals and Body of Cells. Acceptable.
- f. Skim Coat Off Outer Ply. Acceptable.
- g. Loose Edges. 1/2-inch maximum dimension.
- h. Missing Coat. Not Acceptable.

#### 7-6.8.4 RUBBER FACE FITTINGS.

- a. Gouges, Splits, or Indentations on Sealing Surface. 1/16-inch depth by 1/8-inch length maximum dimension.
- b. Weather, Ozone Checking of Surfaces Other than sealing Surface. Acceptable.
- c. Weather, Ozone Checking of Sealing Surface. Not acceptable.

#### 7-6.8.5 SEALING SURFACE WITHOUT O-RING GROOVE.

- a. Scratches Within Sealing Area. Not acceptable (figure 7-11).
- b. Burrs on Mating Surfaces. Not acceptable (figure 7-11).
- c. Corrosion or Rust. Not acceptable.

#### 7-6.8.6 SEALING SURFACE WITH O-RING GROOVE.

- a. Minor Surface Damage Outside O-Ring Groove other than Corrosion or Burrs. Acceptable.
- b. Physical Damage to O-Ring Groove. Not acceptable.
- c. Corrosion. Not acceptable.
- d. Cement or other Foreign Material in O-Ring groove. Not acceptable.
- e. Bent or Broken Fittings or Damaged Dome Nuts. Not acceptable.
- f. Elongated or Torn Holes in Fitting Flange of Cells Using U.S. Rubber Removable Two-Piece Metal Compression Fittings. Acceptable if elongation or tear does not extend beyond outer or inner sealing groove of inner ring or over 1/2 the distance to the next hole.
- g. Thread-Damaged Fittings. Acceptable if serviceability is not affected.

#### 7-6.9 INSPECTION PROCEDURES FOR DEPOT MAINTENANCE OF TIME-PHASE SCHEDULED AIRCRAFT AT AFMC DEPOTS OR CONTRACTOR FACILITIES.

7-6.9.1 Aircraft Using Self-Sealing Cells. If an aircraft MDS has a history of fuel cell activation all cell shall be removed and inspected. If there is no history of activation on a particular aircraft

MDS, the aircraft shall be inspected for visible leakage with fuel in the system.

7-6.9.2 Aircraft Using Bladder-Type Cells. Aircraft shall be tested for leakage while there is fuel in the system.

## 7-7 FUEL CELL REPAIRS.

7-7.1 REPAIR OF INSTALLED CELLS. If an installed cell is determined to be leaking, repairs may be accomplished while the cell is in the aircraft. Partial removal of the cell may be required for some repairs. A decision to remove the cell or accomplished the repair while the cell remains on the aircraft shall be based on; time required to remove the cell, difficulty of the task, availability of spares, and probability of undetected leaks. The following defects may be repaired while the cell is installed: pinholes, inner liner cuts, loose supports or hangars, blisters, loose seams or patches, weather-ozone checking when cords are not damaged, and self-sealing cell activation less than three inches in diameter.

### 7-7.2 REPAIR CAPABILITY RESTRICTIONS.

7-7.2.1 Each activity is encouraged to repair all fuel cells to the fullest extent possible. Repair capability will be based on tools, equipment, facilities, skills, frequency of each repair, and mission requirements.

7-7.2.2 The following repairs are generally best performed at depot or contractor facilities:

- a. self-sealing cell repairs.
- b. repair or replacement of hangars or straps.
- c. repair or replacement of lacing ferrules.
- d. repair or replacement of fittings.
- e. corner repairs.
- f. extensive weather-ozone checking.

7-7.2.3 The following repairs are usually accomplished at the field level.

- a. pinhole damage.
- b. closed hole or slit type damage.
- c. blister repair.
- d. loose seams or patches.
- e. weather-ozone checking requiring a patch less than 12-inches square.
- f. corrosion treatment.

7-7.2.4 The following conditions warrant condemnation of the cell upon approval from the system manager:

- a. Self-sealing cell activation in excess of 200 square inches or which extends into a corner or step-off area.
- b. Damage in an awkward location making patch roll-down impossible.
- c. Weather-ozone checking of the inner liner which exceed five percent of the total surface area or which requires a patch larger than 36-inch square or equivalent area.

## 7-8 REPAIRING BLADDER-TYPE CELLS (EXCEPT GOODYEAR VITHANE).

7-8.1 GENERAL. These cells are of lightweight construction composed of one or more plies of rubberized nylon or rayon fabric on the exterior of the cell, a nylon barrier and a ply of rubberized rayon or nylon fabric or Buna-N gum on the interior. When the nylon barrier is suspected of being damaged an inside repair shall be made.

### 7-8.2 TYPES OF DAMAGES AND REPAIRS.

7-8.2.1 Pinhole Type Damages. A pinhole type damage which penetrates the nylon barrier will require an inside patch. A patch will not be required on the cell retainer unless the cell has been sharply creased in the area of the leak or the retainer cords are damaged.

7-8.2.2 Repairing Weather-Ozone Checked Inner-Liners. Cells with weather-ozone checked inner-liners that do not exceed a maximum of five percent of the total surface of the cell or do not exceed 36 by 36 inches or equivalent for any one patch shall be repaired as per paragraph 7-8.6.3.

7-8.2.3 Blister Damage. A blister is caused by trapped air between the liner and barrier, or between fabric or Buna-N gum and the nylon barrier, or between the layers of nylon in the nylon barrier. Pattern, location, size and leakage are the main factors affecting the cell. Blisters on the bottom and lower sides of the cell are subject to more pressure from the fuel than those in the top and upper sides of the cell. Blisters equivalent to 1/2 square-inch are not detrimental and need not be repaired; however, if two or more are found within a six square-inch area, they shall be repaired as per paragraph 7-8.6.4.

7-8.2.4 Corner Repairs. Pinhole leaks in irregular corners (less than 90 degrees) shall be repaired with small patches, 1/2-inch in diameter or larger, to facilitate application without wrinkles as per paragraph 7-8.6.8.

7-8.2.5 Inside/Outside Repairs. Cells with Buna liners shall be repaired with Buna-N sandwich material. Cells with fabric liners shall be repaired

with nylon sandwich. If nylon sandwich is not available, Buna-N sandwich material may be used.

7-8.3 Materials required. Buna-N sandwich material, Buna Nylon material, emery cloth, solvent (MEK, MIBK, or MIL-C-38736), cement (MIL-A-9117, p/n 1895C, or p/n LP729), stiff bristle brush, Buna Vinylite lacquer, clean absorbent lint free cloth, heater, non-waxed pencil, vacuum cleaner, hand roller, airfoam hot patch.

#### 7-8.4 REPAIR PROCEDURES.

7-8.4.1 Support cells, if required, in the area around the damage so that the edges will be aligned properly in their natural positions (see figure 7-16).

7-8.4.2 Mark the area two inches in all directions from the damage on the inside of the cell and 2 1/2-inches on the outside with non-waxed pencil.

7-8.4.3 Buffing. Buffing may be done by hand using a medium grit emery cloth or with an air driven power buffer. A 320 grit surface is recommended for the power method. Buffing shall be sufficient to remove all gloss, leaving the surface covered with fine scratches. Buff enough to clean 1/4-inch area around the largest patch to be applied. (See specific repair procedures for patch size.) Care shall be taken when buffing the interior or exterior fabric of cell walls. Buffing through fabric causes additional damage.

7-8.4.4 Patches. Cut a beveled patch from the appropriate repair material to extend 1 1/2-inch from the edge of the damage in all directions for inside repair and two inches from the edge of the damage in all directions for an outside repair. Shears shall be tilted during cutting to achieve the beveled edge. The patch edges shall be a smooth rounded outline. The bottom or contact side shall be buffed in the same manner as the cell. Only one patch is required on the interior flat surface and one on the exterior flat surface of the cell for damages less than three inches in size. Repairs to larger damages require two patches on both the inside and outside of the cell. The edges of the first patch are to be well "feathered" to provide adhesion and to prevent the formation of a channel between the two patches. The second patch shall be one inch larger in all directions than the first.

7-8.4.5 Cleaning. The cell and the patch shall be cleaned with a clean cloth moistened with solvent immediately before cementing. Do not touch the surfaces being cleaned since fingers and hands leave an oil film that will prevent adhesion of the cement.

7-8.4.6 Cementing. Apply cement in accordance with the manufacturer's instructions. If manufacturer's instructions are not available: Apply three coats of cement to both the cell and the patch. Allow each coat to thoroughly dry before the next coat is applied. If more than 24 hours has elapsed since application of final coat of cement apply two more layer prior to activation.

7-8.4.7 Patch Application. Apply in accordance with manufacturer's instructions or use the following procedure. When the third coat is dry activate the cement, on the cell and patch, by wiping with cheesecloth moistened with solvent. Activation of the cement will make the cement tacky. To determine if the cement is tacky, press a knuckle gently against the surface and withdraw it. Cement should feel tacky without adhering to the knuckle (the knuckle test). When the areas are sufficiently tacky, center the patch over the damage (see figure 7-18) and roll down firmly with a 1/4-inch hand roller, starting from the center of the patch and working to the outer edges (see figure 7-19). This will help prevent trapped air or a blistered condition.

7-8.4.8 Care shall be taken not to apply the patch before the cement has reached the proper stage of tackiness. If the cement has reached the proper stage before the patch is applied, there will be no skidding or sliding of the patch immediately after application. Sliding shall not be evident in any area of the patch. If blistering or poor adhesion is found in the patch, it shall be removed. A clean cloth moistened with solvent and rubbed briskly over the cement before the cement is completely dry will remove the patch satisfactorily. After the solvent had dried completely, (approximately one hour) a new patch shall be applied, using three coats of cement applied in accordance with paragraph 7-8.4.f.

7-8.4.9 Repair Inspection. No inspection shall be made on the repair patch for 24 hours. After the patch has set for 24 hours, without movement of the cell, check for looseness. Any loose patch shall be removed and reapplied. Seal the edges with two coats of cement after the patch has been accepted as serviceable and allow to dry completely.

7-8.4.10 Additional Patches. After the repair inspection is completed on the first patch, the procedure may be repeated as required to apply additional patches. After the final patch is inspected and accepted the cell must cure for an additional 48 hours. The outside patch will be coated with two coats of Buna Vinylite lacquer.

7-8.5 Vulcanizing (Hot Patch) Repair. This method is accomplished by the same method as stated in paragraph 7-8.4, except for the cements

used and the curing cycle. The curing cycle is reduced from 72 hours to two hours.

7-8.5.1 Buff the inner-liner enough to clean a 1/4-inch wide area around the largest patch to be applied as described in paragraph 7-8.4.4.

7-8.5.2 After the prepared patch has been rolled down, place 1/4-inch to 1/2-inch thick cloth foam and a 1/8 to 1/4-inch thick aluminum plate over entire surface. Place a plate, as above, on the opposite side of the repair.

7-8.5.3 Apply a heating unit to the plate covering the patch and secure with a C-clamp. Tighten until firm. Do not distort cell.

7-8.5.4 Apply heat for one hour at 290°F +/-10°F (surface temperature of heating unit). Allow the unit to cool to room temperature before removing C-clamp and plates.

7-8.5.5 Inspect repaired area for proper adhesions of patch. If loose edges are found, re-cement area and re-cure as stated in paragraph above.

7-8.6 SPECIFIC DAMAGE REPAIRS, BLADDER AND SELF-SEALING CELLS (EXCEPT GOODYEAR VITHANE).

#### NOTE

Specific damage repairs will be accomplished per the general procedures in paragraph 7-8. Exceptions to that procedure are stated with the description of the specific damage.

7-8.6.1 REPAIRING INSIDE CLOSED HOLE OR SLIT-TYPE DAMAGE. (Self-sealing or bladder cells). A closed hole or slit-type damage that does not extend through the barrier of the cell with no displacement of material, and which is not more than two inches long, shall be repaired as outlined in paragraph 7-8.5. This repair will require only one patch on the inside of the cell. Damages which exceed these limitations will be repaired with patches on both sides of the cell.

7-8.6.2 OUTSIDE REPAIRS (SELF-SEALING AND BLADDER CELLS) WITH DAMAGE THAT EXTENDS ONLY THROUGH THE OUTER PLY.

- a. The cell shall be supported around the damage so that the edges of the damage can be properly aligned in their natural positions. Build a trestle or other support inside the cell. Wooden blocks or boards shall be padded or covered with felt or sponge rubber to protect the liner from damage. The procedures outlined in paragraph 7-8.4, shall be followed, except that the patch material will be changed to

outside fabric. After inspection apply two coats of Buna Vinylite lacquer on the patch and the buffed area, allowing each coat to dry thoroughly.

- b. When repairing a self-sealing cell with a closed hole or split-type damage of over two inches, outline an area three inches in all directions from the damage with a silver pencil.
- c. Patch Preparation. Prepare the first patch to extend one inch in all directions from the damage, using the same type of material as that being repaired. This patch shall be buffed and feather-edged on both sides. The second patch shall extend 2 1/2-inches in all directions from the damage and be prepared in the same way as stated in paragraph 7-8.4.

7-8.6.3 REPAIRING WEATHER-OZONE CHECKED INNER-LINERS. Fuel cells with weather-ozone checked inner-liners that do not exceed a maximum of five percent of the total surface of the cell or do not exceed 36 by 36 inches or equivalent surface area for any one patch, shall be repaired as follows:

- a. Mark an area one inch larger in all directions from the checking with a silver pencil.
- b. Make a patch of Buna-N sandwich material to extend 1/2-inch in all directions from the checked area; buff the patch and the area. When using a power buffer, buff very lightly to keep the liner from burning and never buff the liner to the barrier. Clean the patch and the area with a clean, lint-free cheesecloth moistened in solvent.
- c. Apply three coats of cement to the patch and the area. The first coat shall be applied with a stiff bristle brush, working with a circular motion so the cement will be worked into the checks. Each coat of cement shall dry completely before the next coat is applied. Activate both surfaces with solvent and place the patch in position and roll down. After the cement has dried and been checked for looseness, apply two coats to the outer edge of the patch.

7-8.6.4 BLISTER REPAIR. An inner-liner blister is caused by trapped air between the liner and the barrier and is often mistaken for ply separation, which is the loss of adhesion between successive layers. Blisters under 1/2-square-inch are not injurious and need not be repaired; however, if two or more are found within a six-square-inch area they shall be repaired.

- a. To repair a blister, buff its surface and an area extending two inches in all directions from its edge. Slit the blister with a knife from end to end and buff the underside of the loose edges by hand. The slit may be cut to resemble two "Ys" placed end to end. Apply three coats of cement, to the inside surfaces, let each coat dry thoroughly.
- b. Roll down the blister to remove all trapped air. After the cement has dried thoroughly, apply a patch of Buna nylon sandwich material (for a cell with Buna liner); or apply a patch of fabric nylon sandwich material (for a bladder cell with a fabric liner) extending 1 1/2-inches in all directions from the blister's edges. Complete the repair in the same way as for inside damage.
- c. When repairing blister or separation using the hot patch method, clean area with solvent. Apply three coats of hot patch cement (part No. 1895C or part No. 95195) letting each coat dry to the touch before applying the next. When the third coat of cement has dried to the touch, activate the cement with solvent. Roll down the blister to remove all trapped air and install the patch. Apply heating iron.

**7-8.6.5 REPAIRING LOOSE SEAMS AND PATCHES (OUTER EDGE).** Loose lap seams on the inside of a cell shall be repaired as soon as they are noticed. This will prevent the looseness from spreading to the sealant.

- a. Buff an area on top of the loose seal two inches in all directions from the edges of the loose seam, continuing the measurement to the cell wall if necessary. Clean the area inside the separation with a lint-free cheesecloth moistened with solvent. Let the area dry and apply three coats of cement, allowing it to dry thoroughly between coats. Wipe the cemented area with lint-free cheesecloth moistened with solvent. This will yield a tacky condition. Firmly roll down the loose seams to remove trapped air and let the seal dry before proceeding.
- b. Cut a patch of Buna-N sandwich material or nylon fabric sandwich material to extend 1 1/2-inches in all directions from the edge of the loose seams. Round the corners slightly and bevel the edge of the patch. Buff the patch on the side to be cemented to the cell with the beveled side out. Clean the buffed surface of the patch and cell with solvent, apply the patch and complete

the repair in the same way as to an inside injury. Seal edges of patch with two coats of cement.

**7-8.6.6 LOOSE LAP SEAMS.** Loose lap seams on the outside of the cell shall be repaired in the same way as described in paragraph 7-8.6.5, except the material comparable to the outside material of the cell shall be used. Loose patches shall be removed and replaced.

**7-8.6.7 REPAIRING HANGAR SUPPORTS AND STRAPS.**

- a. Many cells require external or internal support hangers to hold the cell in installed position. Some larger cells have straps on the outside for handling and packing convenience. Most fittings are single flange construction and are not difficult to install. When a damaged hanger, strap or fitting is found it shall be repaired or replaced.
- b. Many hangers have metal inserts. To remove a fitting of this type, the fabric shall be cut away around the insert and used as a guide in removing the fitting. Hangers without the metal inserts shall be buffed off or pulled off using solvent. If solvent is used, the repair shall be delayed for one hour to allow the area to dry completely. When buffing the old fitting flange, care shall be taken not to break the fabric on the cell.
- c. Buff the contact side of the new fitting. Clean the fitting and an area on the cell which has been buffed 1/2 inch larger than the flange of the new fitting. Apply three coats of cement, allowing each coat to dry completely. Activate both cemented surfaces with lint-free cheesecloth moistened with solvent. When the surface is properly tacky, place a hanger directly over the old hanger location and roll down firmly with a roller.
- d. Prepare a cover patch that extends one-inch beyond the fitting flange. Cut out the center of the patch and allow one-inch to overlap the fitting flange. Buff the inside of the patch and the area in which it is to be installed. Clean the area and apply three coats of cement to both surfaces, allowing each coat to dry completely. Activate both surfaces; place in position and roll down. After the cement has dried, apply two coats of cement to the entire buffed surface.
- e. Repair replacement procedure for the ferule teflon cylinders. Remove the excess

remaining cement from the nylon strap by any suitable means, taking care not to damage the strap. Use cheesecloth moistened with solvent to clean the area from which the adhesive was removed. Apply a coat of cement to the cleaned surface on the strap.

**7-8.6.8 INSIDE CORNER REPAIRS.** All inside corner repairs require a double (two-layer) patch. To prevent wrinkling or stretching the repair material, these patches shall be cone-shaped and shall fit accurately into the corner.

- a. Buff the area around the damage for two inches in all directions from the edge of the damage in the same way as when repairing a flat surface.
- b. Cut a patch of Buna nylon sandwich material large enough to extend 1/2-inch in all directions from the edge of the damage. Cut a single slit in the patch running from the outside edge to the apex of the corner. At the end of the slit in the center of the patch make a second slit 1/8-inch long at a right angle to the first slit (see figure 7-21).
- c. Before any cement is applied, fit the patch carefully into the corner. Trim it to size and place the slit so that the lap will form itself to a flat surface of the cell. Use a silver pencil to lightly mark an outline of the patch on the cell with the patch in place, indicating the location of the slit so that the patch can be returned to the same position after cementing.
- d. Patch shall be buffed on both sides and feather-edged before cementing. Buff top side of overlapped patch at the slit, wash and cement.
- e. Three coats of cement, shall be applied to the buffed area of the cell and the inside of the patch. When the third coat is completely dry, wipe with a cheesecloth moistened in solvent. When tacky, the patch shall be aligned with the outline previously drawn on the cell. Press down a narrow strip of the patch running from the outer edge of the corner of the slit. Place the patch so that it accurately matches its outline and so that the inner end of the slit actually falls in the apex of the corner.
- f. The patch shall be worked down with a hand roller. Start rolling from the edge of the slit which has already been stuck down and work around the patch to the outer edge of the slit. Be extremely careful to

avoid any wrinkles or trapped air. If the roller or stitcher is too awkward the patch may be applied with a rolling motion of the finger.

- g. After patch has been rolled down, apply three coats of cement to the flat surfaces that form the lap; allow each coat to dry thoroughly before applying the next coat. When the third coat is dry, moisten the area with a cheesecloth moistened with solvent and roll down the lap.
- h. Be sure that all edges are rolled down securely. If some do not stick, wipe the loose places with cheesecloth moistened with solvent. If loose edges are found after two hours dry time, apply another thin coat of cement. Allow to dry and roll again after it has been remoistened with MIBK or MEK solvent. If the patch is still loose at any place, it shall be removed and scraped, the cell cleaned of cement and the repair restarted.
- i. After the first patch has been carefully examined and found to be smooth and tight, apply a second patch in the same manner as the first after it has been fitted to the corner by making a slit and overlapping. The location of the overlap on the second patch shall be opposite that of the first patch (See figure 7-21).

**7-8.6.9 OUTSIDE CORNER REPAIRS.** Outside corner repairs are made in approximately the same manner as inside corner repairs. Patches are cut from outside repair material similar to the outer ply construction and are applied by the same method as outside patches for slit-type injuries on a flat surface. The lap on the outside corner patch shall be covered by an extra strip of repair fabric extending 1/2-inch on each side of the outside edge of the lap from the apex of the corner to the outer edge of the patch.

**7-8.6.10 EXPOSED FABRIC REPAIRS.** Exposed fabric outside and inside of fuel cells will be repaired using procedures outlined in paragraph 7-8.5, or figure 7-26.

## 7-9 SELF-SEALING CELL REPAIR.

**7-9.1 GENERAL.** Repairing separations of over three square inches. Sealant separation or swelling is caused by fuel coming in contact with the sealant, and can be caused in one of two ways. A pinhole or cut through the nylon barrier or spillage of fuel to the outside of the cell, which will wick to the sealant, causing swelling or separation, and will sometimes split or rupture the innerliner. The separation shall be trimmed and care shall be

taken not to damage any plies. After all damaged plies have been removed, trim two inches beyond to make sure that all fabric that might be fuel soaked is removed, then the area shall be checked. If the damaged area is over 200 square inches or extends into a corner or step off area, the question of whether to repair or condemn a cell will depend upon the availability of spare cells, cost involved, or extensive damage to the cell which would make repairs extremely difficult or in some cases impractical.

#### 7-9.2 INSIDE PREPARATION.

7-9.2.1 After the damaged area has dried for 72 hours, the plies shall be trimmed to allow a two-inch step or lap of each ply. If all plies were damaged and removed, the repair shall start by applying a patch to the outside. This patch shall be of fabric material of the same weight in which the cell was manufactured, and shall be large enough to extend four inches in all directions from the edge of the cutaway section. Center the patch over the section and using a silver pencil, outline an area 1/2-inch larger in all directions than the outside edge of the patch, buff the patch and the outlined area on the cell, and clean the area and the patch with cheesecloth moistened in solvent.

7-9.2.2 Apply three coats of cement to the area and the patch, and allow each coat to dry thoroughly.

7-9.2.3 Before the patch is applied, wipe with cheesecloth moistened in solvent. Make the knuckle test to determine if the cement is tacky.

7-9.2.4 When the cemented areas are tacky, the patch shall be centered within the silver lines and rolled down firmly with a 1/4-inch hand roller, starting at the center of the injury and rolling outwards. This will require two repairers on a large cell as one repairer must enter the cell and back the area being rolled with a sheet of plywood or other solid backing. All sharp corners or edges shall be removed from the backing platform.

7-9.2.5 After the outside patch has dried for 24 hours, the rest of the repair shall be made from inside the cell. Make a patch of repair fabric to fit the first inside step area of the repair and buff both sides. Apply three coats of cement to one side of the patch and to the inside of the cell. When the last coat of cement is dry, wipe with cheesecloth moistened in solvent. When tacky, install the patch by holding the two edges together, centering the patch, and rolling it into place, starting in the center and rolling outward.

7-9.2.6 After the fabric ply has been installed and carefully checked to make sure that there is no trapped air, cut the next ply of gum sealant to

fit as close as possible to the area in which it is to be applied. Remove gloss from both sides of the uncured sealant by using 120-grit sandpaper by hand. Care shall be taken in cleaning the sealant and only a minimum amount of solvent shall be used. Solvent will cause the sealant to swell. Apply three coats of cement to both the sealant and the area in which it is to be applied. Care shall also be taken in rolling this ply into place, because the sealant will cut easily under the pressure of the rollers.

7-9.2.7 The next ply is cut from outside fabric repair material. Buff both sides and clean. Apply three coats of cement and roll down in position after the cement has reached its proper tackiness. The next ply shall be of sealant gum and shall be prepared and applied in the same way as the first ply of sealant gum.

7-9.2.8 After the second ply of sealant gum has been applied, it should bring the repair up to the level of the outer ply. If additional thickness is needed to obtain this required level, sealant gum, 0.055-inch gage or 0.110-inch gage, shall be used to obtain the required level.

7-9.2.9 After the required level has been reached prepare a patch of Buna nylon sandwich material, cured on both sides. The patch shall be cut large enough to extend two inches in all directions beyond the cut-away area. This patch shall be buffed and feather-edged on both sides to prevent air entrapment at step-off area when the cover patch is applied. After the patch is buffed and cleaned, apply three coats of cement to the cell and patch and allow to dry to knuckle-test consistency. Activate the cement with solvent. Center the patch on the repair, and roll down.

7-9.2.10 When the nylon sandwich patch has been completely installed, no air bubbles are found, and all edges are rolled down, prepare a cover patch from Buna nylon sandwich material. The patch should extend three inches beyond the first inside patch. Buff the inside of the patch and bevel the patch on the outside edge, apply three coats of cement to both the patch and the damage area. Allow both areas to dry to knuckle-test consistency. Activate the cement with solvent, roll down the patch, and apply two coats of cement around the edges of the patch.

7-9.2.11 The cell shall be kept in the position in which it was repaired for 24 hours before any flexing is allowed. Repair then may be flexed normally to permit inspection for air bubbles.

7-9.3 SEPARATION THAT EXTENDS INTO FITTING AREA. A separation that extends into and under a fitting flange shall be repaired in the

same way as an inside preparation with the following exceptions.

7-9.3.1 Line the fitting with a fine line of silver pencil, making the lines long enough to extend beyond the repair area, and cut out the fitting.

7-9.3.2 When installing an outside cover patch, the patch shall be cut in a shape and size large enough to extend completely around and three inches in all directions from the throat of the fitting.

7-9.3.3 After the repair has been completed install the fitting.

#### 7-9.4 REPAIRING HOLE-TYPE DAMAGE LESS THAN THREE INCHES IN DIAMETER (BUILD-UP REPAIR).

7-9.4.1 Mark two circles around the damage on the outside of the cell wall with a silver pencil. Draw the inside circle large enough to include all damaged sealant and ragged edges, but not smaller than three inches in diameter. Draw the outer circle on a one inch larger radius (see figure 7-23). Buff an area on the cell extending from the outside circle outward for a 2 1/2-inches larger radius and remark the outside circle. Using the inside circle as a guide, cut away the cell material with a knife blade held at a right angle to the cell wall. Then bevel-cut the edge of the hole, using the larger circle as one guide and the edge of the liner in the hole as another. This results in a shallow bevel of about 30 degrees, and provides an efficient adhesion surface.

7-9.4.2 Buff the innerliner for 4 1/2-inches away from the edge of the hole. Make a patch of Buna nylon sandwich material three inches larger than the diameter of the hole. Make a second patch of repair Buna material to overlap the first patch 1 1/2-inches. Feather-edge the first patch and buff both sides. Apply cement to the innerliner of the cell and with MIBK or MEK solvent. When proper tackiness is obtained, center the patch over the hole and roll down. Buff the down side of the second patch and, when the first patch is dry, apply three coats of cement to the areas and the patch. When the cement is properly tacky, center the patch and roll down. When the cement is dry, check for air bubbles and apply two coats of cement to the edges of the patch.

7-9.4.3 Build a trestle or other support inside the cell under the area to be repaired. Wooden blocks and boards used inside cells shall be padded or covered with felt or sponge rubber to protect the liner from damage (see figure 7-16).

7-9.5 LAYING AND ROLLING SEALANT. Cut as many patches of sealant as there are layers of sealant in the injured area one inch larger in diameter than the diameter of the cut-out in the cell. Use sealant material comparable in thickness to the material in the area of the damage. As layers are applied, coat each surface with three coats of cement, on both sides of the sealant for adhesion, and let them dry to knuckle test consistency. Apply each layer separately rolling down thoroughly. Care shall be taken not to cut the sealant with the roller. After the repair has dried carefully trim the excess sealant to a line flush with the outside of the cell (see figures 7-24 and 7-25). A handy tool for fuel work can be made from an ordinary soldering iron. Braze a semicircular piece of copper approximately 3/8-inch thick and cut on a one-inch radius onto a 3-1/12 inch length of 3/8-inch round copper stock. Taper the head down so that the tool resembles a rod cutter. Refer to Section VIII for fabrication instructions. Insert the finished part into the soldering iron in place of the regular copper tip. This is known as a "hot knife" and is adaptable to removing fittings, trimming sealant, etc. It cuts very easily when hot and care shall be taken not to cut too deeply. Workmen shall practice on a condemned cell before using the knife for actual repair. Apply an outside retainer or cover patch the same as that outlined in paragraph 7-9.4.a and 7-9.4.b, except that outside material fabric shall be used.

#### 7-9.6 REINFORCING WRAP FOR TUBULAR FITTING.

7-9.6.1 In order to strengthen fittings and retard normal ozone-cracking of synthetic rubber, all tubular or barrel type fittings shall be wrapped with outside repair material. Light gage fabric material shall be used to provide flexibility. The procedures for wrapping fittings will vary with the type of fittings involved, although the principle is the same. Wraps for two-piece fittings (i.e., a fitting in which the tubular or protruding barrel is molded separately and is detachable from the flanges vulcanized to the wall of the cell) will extend only the length of the tubular portion and will terminate 3/8-inch from the base of the tube (see figure 7-26). The normal procedures for wrapping fittings are:

7-9.6.2 Determine the extent to which the fitting surface is to be wrapped. This shall include as much of the tubular portion as possible and, in one-piece fittings, the fingers shall extend two inches onto the flat surface of the cell (see figure 7-27).

7-9.6.3 Wrap the fitting with paper to make an exact template of the required stock. Allow enough stock to get to good burr point.

7-9.6.4 Cut the patch from outside repair fabric, using template as guide, which has been buffed on the down side. The template may be saved and used on other fittings of the same manufacturer and stock number.

7-9.6.5 Remove any partial fabric wrapping which may have been previously applied to the fittings.

7-9.6.6 Buff the surface on the fitting by hand with 80 to 120-grit sandpaper. Do not use a power buffer. Fittings are easily damaged and are difficult to replace.

7-9.6.7 Apply three coats of cement to the fitting surface and patch. Allow each coat to dry completely.

7-9.6.8 Buff and cement the fabric wrap in the same way as when preparing an outside patch.

7-9.6.9 Apply the fabric wrap carefully to the fitting, rolling down securely and burring at adjoining surfaces. A mandrill the same size as the inside diameter of the tubular fitting, sometimes may be inserted to facilitate rolling.

7-9.6.10 After one-piece fittings have been wrapped, the fingered area shall be covered with a reinforcing patch. Cut the cover patch so that its inside diameter is the same as the outside diameter of the base of the fitting and so that the outside diameter of the cover patch extends 1/2-inch beyond the fingers of the wrap.

## 7-10 REPAIR OF FITTINGS.

7-10.1 REPLACING FITTINGS (SELF-SEALING AND BLADDER CELLS). Fitting replacement is not generally considered a difficult operation, although it is a lengthy one. Care shall be taken to achieve accuracy. The materials and tools are the same as those used for other repairs.

7-10.2 REPAIR OF FITTING O-RING GROOVE AREA. Damage to fittings in some instances is cause for rejection of an entire fuel cell particularly when replacement fittings are not available. This situation, unfortunately, is most prevalent with fuel cells of limited production, used in aircraft no longer being manufactured. Since there is normally a requirement for this type of equipment, it is necessary to maintain the capability of servicing these fuel cells and replacing or repairing the fittings. It is advisable to retain a stockpile of salvaged fittings from scrap fuel cells in order to readily replace damaged fittings without undue delay. However, when new or used replacement

fittings are not available or obtainable within a reasonable length of time, the ability to repair fittings is invaluable. Prevalent damages that occur to fittings are cracks and breaks of the O-ring groove and flanges. This results from improper disassembly or improper alignment when connected to adjacent assemblies. The O-ring groove flanges are generally thin in cross-section as compared to the body of the fitting and therefore break more readily. When the damaged fitting cannot be conveniently replaced or a replacement fitting is not obtainable and the break is confined to the fitting O-ring groove area, a satisfactory repair can be made. Two types of repairable damage are recognized:

7-10.2.1 Broken O-ring groove flanges. The flange between the O-ring groove and the fitting opening is sometimes broken or chipped due to incorrect installation of a cover plate or fitting.

7-10.2.2 Break of the fitting body extending from the corner at the outside diameter of the O-ring groove through to the fuel cavity.

7-10.2.3 Light burrs, scratches, nicks or other damage to the sealing surface of fittings with or without O-ring grooves. Damage up to 0.005 inch will be repaired in accordance with paragraph 7-10.10.

7-10.3 EXTENT OF DAMAGE. Fittings should not be repaired if badly distorted or if the cracks are other than simple straight or slightly curved cracks. Do not repair cracks through O-ring groove areas if longer than twice the distance between adjacent threaded inserts. Do not make more than two repairs on any fitting. Both types of repair are to be at least 90 degrees apart and, in no case, closer than nine inches measured circumferentially between the ends of the repairs. Do not repair broken O-ring flanges if the damaged area is over one inch long.

### 7-10.4 REPAIR OF BROKEN O-RING GROOVE FLANGE.

7-10.4.1 If the fitting is distorted, reshape using the bolt-ring portion of the mating part as a guide. Conveniently shaped dolly blocks and soft-faced hammers may be used to restore the fitting to its normal shape. Use caution to prevent further damage to the fitting.

7-10.4.2 Contour the damaged area to receive the epoxy resin patching compound. Use suitably shaped rotary files and scrapers for contouring. These scrapers are also used in dressing the completed repair. Figure 7-28, illustrates the tang end of a file being used as a scraper. Note the ground taper. Using rotary file, clean up the jagged edges of the break. Cut a taper in the bottom of the O-

ring groove (See figure 7-28). The taper shall be such that the outer diameter of the O-ring groove remains at its original level while the inner diameter of the retainer land base will be ground to within 1/64 inch to 1/32 inch from the inner surface of the fitting. The taper is in the radial direction. The taper shall extend circumferentially from one end of the repair to the other. As the grinding tool approaches the end of the damaged area, rotate the tool to maintain the angle of taper on the bottom of the O-ring groove while meeting the inner face of the O-ring groove flange at an angle of 30 degrees to the tangent. Holding the tool in this position, grind a 30-degree knife edge taper on the inner face of the flange. Fair the tapers into each other at this intersection. A coneshaped rotary file is best for grinding the inner face of the flange.

7-10.4.3 Use a 180-grit emery cloth and sand all ground surfaces thoroughly. Wash all dirt and grit from the repair area with solvent.

7-10.4.4 Fabricate two retainer rings from aluminum alloy sheet of convenient thickness to retain the patching compound. One ring is to fit the inner face of the flange and the other ring is to fit the outer face. Form the rings so that springback will hold them in place. The inner ring should be approximately 1/16 inch to 1/8 inch higher than the flange. The outer ring can be adjusted to the same height by sliding it up or down. (See figure 7-28.)

7-10.4.5 Cover the faces of the rings that will be in contact with the patching compound with cellophane or equivalent tape. Clean the damaged fitting with solvent and install the rings in place on the fitting, being sure that they contact the repair area securely.

7-10.4.6 Mix the epoxy patching compound. Fill the space between the rings with patching compound. Use a thin instrument such as a tongue depressor to work the compound. Avoid entrapment of air pockets. As the space between the rings is filled, the compound oozes under the ring and onto the taper on the bottom of the O-ring groove. Spread the compound, as necessary, to bring the level slightly higher than the surrounding area.

7-10.4.7 Allow the repair to cure at room temperature eight to 16 hours or until it is solid. Remove the retainer rings. Remove any excess epoxy from the O-ring groove with a scraper, also use an air nozzle to remove the epoxy particles during the scraping operation.

7-10.4.8 Dress the repair to match the contour and surface finish of the fitting. Maintain the dimensions of the O-ring groove accurately.

7-10.5 REPAIR OF BREAK THROUGH THE FITTING BODY. Cracks occur on fittings having a wide O-ring retainer land and a relative thin cross-section through the bottom of the O-ring groove. Repair as follows:

7-10.5.1 Straighten the fitting if it is bent. Use caution to avoid further damage to the fitting. Stop drill the ends of the break with a No. 50 drill.

7-10.5.2 Working from the inside, vee the break so that the bottom of the vee is approximately one-half way through the work piece. The included angle between the faces of the vee should be approximately 60 degrees.

7-10.5.3 Use 180-grit emery cloth to sand the surrounding area thoroughly.

7-10.5.4 Use a jeweler's disc saw to score the insert bosses and land to 1/32 inch depth. Score the fitting along two lines. Use a hacksaw blade scraper ground to have a round cutting edge to remove the sharp corners at the bottom of the jeweler's saw scores. Do not score the fitting in areas which cannot be reached by the hacksaw blade.

7-10.5.5 Vee out the portion of the crack remaining in the O-ring groove. Since the breaks usually occur next to the rear vertical face of the groove, it will be necessary to slightly undercut this face in order to clean up the break. Thoroughly clean the repair area with solvent. Remove all contamination.

7-10.5.6 Provide a dam for holding the epoxy compound in place. Use noncuring aircraft sealers, modeling clay, plaster, or other convenient materials. Avoid contaminating the bonding surfaces of the repair area with these materials.

7-10.5.7 Prepare the epoxy compound and apply to the repair area. Do not trap air bubbles. Arrange the cell so that gravity will assist to hold the repair material in place as it cures. Allow the compound to cure.

7-10.5.8 Dress the repaired area in the O-ring groove to conform to the original dimensions and surface finish. Dress the edge of the reinforcement on the inside surface of the fitting using a powered cone-shaped rotary stone.

7-10.5.9 When finished with the fitting repairs, ascertain that all debris is removed from the cell cavity. Inspect the repair to determine that adhesion is complete and that the patching compound is well cured. When well cured, the compound should not dent with a fingernail. Inspect for

porosity. A small number of pinpoint bubbles are acceptable.

#### 7-10.6 REMOVING DAMAGED FITTINGS.

7-10.6.1 Locate the old fitting accurately by measuring from selected points of the cell so that the new fitting can be centered exactly in the same position. (See figure 7-30.) A silver pencil shall be used when locating fittings.

7-10.6.2 A fitting shall be replaced with the same type as that removed from the cell. Relocation of fitting openings requires skill and experience and shall be attempted only by journeymen repairers.

7-10.6.3 On fittings without metal inserts, cut the fitting flange flush with the outside sealing surface of the fittings. Then cut out the flange of the fitting to the edge of the cell wall. Care shall be taken to avoid cutting the cell, and enlarging the original opening.

7-10.6.4 On fittings with metal inserts, cut out the fitting, using the metal insert as a guide.

#### 7-10.7 INSTALLING NEW FITTINGS.

7-10.7.1 Using an emery buffer, remove enough of the inside and outside flange of the old fitting and the ply that covers it to reduce the thickness of the cell wall so it will fit between the flanges of the new fitting.

7-10.7.2 Buff the inside and outside surfaces of the cell where flanges of the new fittings are to be placed. This buffing shall cover an area extending two inches beyond the edge of the flanges when the new fitting is set in place.

7-10.7.3 If the new fitting has not been buffed, the surfaces inside and outside both flanges must be buffed.

7-10.7.4 If the cell wall does not have enough thickness to fill the space between the flanges of the new fitting, apply a patch of Buna inside repair material to the inside of the cell in the same way as when applying an inside patch. This patch shall be large enough to extend one inch beyond the area to be covered by fitting flange. Also the center shall be cut out to match the hole in the cell and all loose edges shall be trimmed. Before the patch is applied, its outside surface shall be buffed and the patch feather-edged. Before inserting the fitting through the opening, the size and shape shall be carefully checked. This can be done with a pair of calipers. The diameter of the cell opening shall not be less than the diameter of the throat of the fitting, but the diameter of the cell opening may be up to 1/4-inch larger than the overall diameter of the throat of

the fitting. On fittings that are not circular, the cell opening may be up to 1/4-inch wider than the throat of the fitting to be installed. Filler is not required for the void between the throat of the fitting and the cell wall.

7-10.7.5 Moisten the surfaces of the fitting with MEK or MIBK solvent and force the fitting through the opening in the cell, pulling the outside flange through from the inside of the cell. Check the alignment of the new fitting in the cell opening. If the opening is too small, buff until the new fitting flanges lay flat on the cell. If the opening in the cell does not allow a 1-inch bond to the new fitting flanges, the cell shall be condemned. When a satisfactory fit has been obtained remove the fitting from the cell.

7-10.7.6 Cement repair per applicable procedure.

- a. Non Vithane air cure.
- b. Non Vithane vulcanizing hot patch.
- c. Vithane non self-sealing.
- d. Vithane self-sealing.

7-10.7.7 With clean hands, insert the fitting in the opening of the cell. Aline the fitting carefully so that its location is exactly the same as that of the old fitting. It may be shifted to an off-center position, if necessary, to aline the bolt holes. Press the flange to the cell wall. Use the same procedure on the outside flange.

7-10.7.8 Refer to applicable procedures listed in step paragraph 7-10.7.5, for fitting activation and curing.

7-10.8 APPLYING COVER PATCHES OVER FITTING FLANGES ON NONVITHANE FUEL CELLS. Apply one patch of Buna inside repair material over the inside flange after the cement applied to the fitting has dried thoroughly (45 minutes). Cut the patch 1 1/2-inches larger in all directions than the fitting flange. Cut an opening in the center the same shape as the opening in the fitting, but 1/8-inch larger in all directions. Care shall be taken to avoid getting cement on the sealing surface of the fitting. Patches are cemented and applied in the same way as are other standard patches described in this section. The opening shall be centered carefully so that the amount of material is approximately the same in all directions. Complete repair.

7-10.9 APPLY COVER PATCHES OVER FITTING FLANGES ON VITHANE FUEL CELLS.

7-10.9.1 Apply one patch of FT235 repair fabric over the inside flange. Cut the patch 1 1/2-inches larger in all directions than the fitting flange. Cut

an opening in the center the same shape as the opening in the fitting, but 1/8-inch larger in all directions. Care shall be taken to avoid getting cement on the sealing surface of the fitting. Patches are cemented and applied in the same way as other standard patches. The opening shall be centered carefully so that the amount of material is approximately the same in all directions.

7-10.9.2 Only one patch is used on the outside of the fitting. This patch shall be of outside fabric material which has been cut two inches larger in all directions than the fitting flange. The center is cut to the proper size and shape to accommodate the fitting. A patch applied to a protruding or barrel type fitting shall fit snugly around the base of the fitting barrel. A patch applied to a metal insert fitting shall have an opening 1/2-inch larger in all directions than the gasket or compression surface of the fitting.

7-10.9.3 This fitting replacement procedure may not be practical for all replacements. Inserting the fitting from the outside of the cell may sometimes be convenient. Some installations can be made more easily if the patch is cemented to the flange before the fitting is inserted. Many of these details are left to the judgement of the person making the repair, but the following steps shall always be taken.

7-10.9.4 On Vithane fuel cells, mix cement in accordance with instructions. Apply a coat of cement to the cover and the fitting flange. Allow cement to dry for 15 minutes. Apply a second coat of cement and allow to dry for five minutes.

7-10.9.5 One cover patch shall be installed on each flange of the fitting.

7-10.9.6 The outside patch on the metal insert fitting should not interfere with the gasket or compression surface.

7-10.9.7 Wrap barrel-type fittings.

7-10.9.8 On Vithane fuel cells, tape a piece of release film over the patch. Assure that the release film is larger than cemented area, and remains in place. Clamp and cure the patch in accordance with instructions.

7-10.10 REPAIR OF BURRS, SCRATCHES, NICKS OR OTHER DAMAGE ON THE SEALING SURFACE. (INCLUDING O-RING GROOVE).

7-10.10.1 Lightly sand the damaged area with 600 grit emory cloth. Extend the sanded area no more than two inches beyond either side of the damage. A tongue depressor may be used to assist sanding.

7-10.10.2 Clean the fitting with solvent.

7-10.10.3 Apply chromate conversion coating, MIL-C-81706, in accordance with T.O. 1-1-691.

## 7-11 REPAIRING NONMETALLIC CELLS.

7-11.1 A nonmetallic cell is a combination fuel cell and rigid cell in a single unit. Nonmetallic cells have fabric or plastic shells made integrally with a self-sealing cell and are complete within themselves.

7-11.2 Damage to the nonmetallic portion of a cell less than 10 square inches need not be repaired if the strength of the unit is not impaired. The inner-liner of a self-sealing fuel cell should be repaired and a patch placed over the damaged portion of the nonmetallic cell to prevent fuel from attacking the damaged area. If the damaged area is more than 10 inches but less than 25 inches, the repair shall be made as outlined in paragraph 7-8.5. If some of the material is missing, the missing plies shall be replaced, using a step-down procedure with at least a two-inch step per ply. Due to the hardness of the nonmetallic portion of the cell, do not try to cut the hose to a smooth contour. Fill the entire opening and make sure that there are no air pockets which will expand at high altitudes. The hot knife will be very useful to remove and smooth the sealant. Apply cover patches, inside and out, to extend four inches in all directions beyond the edge of the damage.

7-11.3 Fitting replacement on nonmetallic cells are made in the same way as fitting replacement on self-sealing cells. Fittings for different nonmetallic cells are interchangeable to a limited extent. Fittings may be interchanged in cells which have similar construction and which are equipped with fittings with the same distance between flanges.

## 7-12 FACILITY REQUIREMENTS.

Repair of fuel cells shall be accomplished in a warm, dry place. The temperature should be controlled to maintain 60°F to 90°F. The procedures stated in this paragraph should be followed in sequence to insure that all defects are identified prior to starting repair. Failure to follow this sequence may result in wasted manhours and materials on cell which must be condemned or transferred to depot level repair activities.

## 7-13 SELF-SEALING CELL DRYING.

Self-sealing cells shall be drained and dried thoroughly as soon as possible after the damage is found to prevent excessive swelling of the sealant. Drying may be speeded by placing the cells in a warm (80°F) location, and using a flow of air through the inside of the cells. Higher temperatures will dry out the fuel-soaked sealant next to the injury and will trap fuel in the sealant. The

trapped fuel will cause separation and breakdown in the sealant area at a later date. To prevent this condition, the edge of the damage shall be spread slightly with wooden pegs to allow fuel and fuel vapors to escape from the sealant. This type of damage requires several days to dry.

#### 7-14 CLEANING BEFORE INSPECTION.

The fuel cells shall be cleaned as required with clean, lint-free cloth, moistened with cleaning solvent (P-D-680, Type II) before any inspection is made. Liquid soap, (commercial, liquid, non-abrasive dish or laundry soap/detergent.), and hot water (not to exceed 120°F) may be used for large-scale cleaning. All soap residue shall be removed with clear water and the cells shall be dried thoroughly after cleaning.

#### 7-15 MARKING DEFECTS AND AREAS TO BE REPAIRED.

When marking damaged areas or making alignment marks for fittings or patches, all marks will be made with non-waxed silver, white or yellow pencil.

#### 7-16 TESTING.

Removed cells should be tested if possible to locate all leaks and make a determination of repair feasibility.

#### 7-17 INSPECTION.

All cells shall be inspected prior to beginning repairs.

#### 7-18 REPAIR CAPABILITY AND RESTRICTIONS.

Determination of repair capability will be based on tools, equipment, facilities, skills and frequency of each type of repair at the level of maintenance. Consult the applicable -6 technical order for specific repair restrictions.

7-18.1 The following should generally be considered as field level repairs:

- a. Pin hole damages.
- b. Closed hole or slit type damages.
- c. Blister repairs.
- d. Loose seams or patches.
- e. Self-sealing cell hole damages less than three inches in diameter.

7-18.2 The following repairs should generally be considered as depot or contractor level repairs:

- a. Repair or replacement of hanger or straps.
- b. Repair or replacement of lacing ferrules.
- c. Repair or replacement of fitting.

- d. Corner repairs.
- e. Extensive weather-ozone checking.
- f. Self-sealing cell repair.
- g. Cells with damage exceeding the following limitations should be condemned upon approval of the system manager.
- h. Self-sealing cell sealant activation which exceeds 200 square inches or extends into a corner or step off area.
- i. Injury in awkward locations making a patch impossible to roll down.

#### 7-19 REPAIRING FULLY MOLDED FITTINGS (RUBBER FITTINGS WITH METAL INSERTS).

7-19.1 A fitting which requires replacement of more than 1/3 of the rubber on the sealing surface shall be replaced.

7-19.2 Materials required. Solvent (MEK, MIBK), cheesecloth, Buna-N, cement (MIL-A-9117), heater, heat, transfer fixture, buffing wheel, emery cloth, metal primer (TY-PLY "N").

##### 7-19.3 Procedures.

7-19.3.1 Slight weather cracks on outer sides and radius of protruding fittings where the flange and the radius merge should be repaired by applying a coat of cement (MIL-C-9117), to the crack. Do not use this procedure to repair the sealing surface.

7-19.3.2 Buff or sand damaged area. Remove enough material to ensure only sound material is exposed. If metal insert is exposed, sand insert.

7-19.3.3 Clean all surfaces with solvent.

7-19.3.4 Insert bolts which have been shortened to fit below the surface of the insert, where necessary, to prevent repair stock from flowing into the screw holes.

7-19.3.5 Apply two coats of primer to exposed metal. Apply first coat, allow 30 minutes for primer to dry, apply second coat, allow 30 minutes drying time before proceeding.

7-19.3.6 Prepare enough strips of Buna-N material to fill the void.

7-19.3.7 Apply three coats of cement to both the fitting and Buna-N. Allow each coat to thoroughly dry before the next coat is applied.

7-19.3.8 When the third coat is dry activate the cement by wiping with cheesecloth moistened with solvent.

7-19.3.9 Place Buna-N material on fitting. Ensure enough material is used to fill the void.

Excess material can be buffed off after the curing process is complete.

7-19.3.10 Locally manufacture heat transfer and pressure fixture to vulcanize the fitting. The fixture shall consist of an internal and external pressure plate to conform to the configuration of the cell.

7-19.3.11 Install fixture on fitting and tighten. Turn heater on and regulate temperature to 290°F + 10°F. Heater should fit over the outer face of the pressure plate fixture. The heater shall be small enough to prevent heating the cell.

7-19.3.12 After five minutes retighten fixture. Continue cure for 60 minutes.

7-19.3.13 Turn heater off. Wait for fixture to cool before removing fixture.

7-19.3.14 Buff and clean the new surface, if necessary, to match original portions of cell fitting.

#### 7-20 ALIGNMENT PIN REPLACEMENT.

7-20.1 Some molded fittings use pins to ensure the fittings properly align. Use the following procedure to replace an alignment pin.

7-20.2 Materials required. Buffing wheel, center punch, knife, drill, drift punch.

7-20.3 Procedures.

7-20.3.1 Buff rubber on opposite side of fitting down to insert and pin.

7-20.3.2 Cut rubber from around side of pin or stud.

7-20.3.3 Center punch the pin on the opposite side to remove pin and remove head with a drill. The remaining portion removed with a drift punch. Threaded studs shall be unscrewed.

7-20.3.4 Install a new pin. Using a center punch stake the pin in three equally spaced places around the pin.

7-20.3.5 Repair rubber (paragraph 7-20).

#### 7-21 O-RING FITTING REPAIR.

Many bladder and self-sealing cells have an O-ring fitting. The fitting shall be repaired in accordance with paragraph 7-10, anytime a scratch, nick or burr is found in the critical surface of the O-ring groove. Care shall be used in the inspection of O-ring fittings. Never lift, move or carry a fuel cell by the fittings; they are not handles or handholds, they are easily bent and shall be protected at all times against distortion. A piece of cardboard taped in position will protect the fitting. The sealing surface of an O-ring fitting shall be kept clean.

Remove all particles of dirt, thread, tape, paint, metal shavings and other foreign material from the fitting with cheesecloth moistened with solvent and a tool made of hardwood. If, while cleaning the metal surface of a fitting, the chromate conversion coating is removed, it shall be replaced with the conversion coating MIL-C-81706 in accordance with TO 1-1-691.

#### 7-22 LACING CORDS AND KNOTS.

Many cells use nylon lacing cords to hold cells in place.

#### 7-23 REPAIRING OIL CELLS.

Oil cell repair is unlike fuel cell repair, because most oil cells do not have a nylon barrier. The repair, replacement and application of patches, however, shall be the same as for a standard bladder cell except that inside repair material (Buna-N, 0.035 inch) shall be used for Buna liners; outside material shall be of square woven fabric for fabric liners.

#### 7-24 REPAIRING WATER-ALCOHOL CELLS.

Water-alcohol cells shall be repaired in the same way as are oil cells, as the construction is very similar. If water-alcohol cells are of fabric liner construction the inside repair shall be made with fabric (MIL-C-82255, Type IV); Buna-N liners shall be made with fabric (Buna-N, 0.035 inch); cement shall be MIL-A-9117.

#### 7-25 REPAIRING GOODYEAR (VITHANE) CELLS.

##### 7-25.1 GENERAL.

7-25.2 Vithane fuel cells differ in construction and material from nitrile (Buna-N-Rubber) fuel cells and can be identified by the Goodyear constructive numbers BTC-54A, 67, 49, 69, 85, 86, 101 and number variations such as 86-1. Repair shall be made by entirely different methods and materials. Vithane fuel cell ZF16 37764 incorporates a self-sealing panel on left and right sides of cell. Refer to paragraph 7-26.6, for repairs to self-sealing panels. Vithane construction consists of one or more plies of urethane spray, coated nylon or polyester fabric, a fuel barrier, and a urethane sprayed inner-liner. Buna-N rubber shall not be used for these repairs.

##### 7-25.3 TYPES OF DAMAGES AND REPAIRS.

7-25.3.1 Separations. Remove all loose material. Apply both an outside and inside repair patch.

7-25.3.2 Holes, punctures, cuts, tears or abraded area. Trim away all loose or ragged material and apply an outside and inside repair patch.

7-25.3.3 Loose edges or loose fitting flanges. Abrade the area with emery cloth. Clean with solvent and apply two coats of cement to each contact surface. Clamp and cure.

7-25.3.4 Missing coat. Abrade surface adjacent to the missing coat with emery cloth. Clean with solvent and apply four coats of cement and cure.

7-25.3.5 Sealing surface-metal. For repair of metal sealing surface, see below.

7-25.3.6 Accessory replacement. Abrade the contact surface smooth when adding or replacing accessories.

7-25.3.7 Activated area. Mark out a three-inch, four-inch, or six-inch circle, one that includes all the activated sealant. Cut out material to the marked line, making sure that the cut is made in sound (non-activated) material. Apply the self-sealing repair plug.

#### 7-25.4 REPAIR LIMITATIONS.

7-25.4.1 Inside patches are to overlap the damaged area a minimum of one-inch in each direction.

7-25.4.2 Outside patches, when required, shall be 1/2-inch larger than the inside patch.

7-25.4.3 Separations between layers (or plies) larger than one-inch diameter require repairs.

7-25.4.4 Slits, tears, and activation are limited to six-inches maximum length, or diameter.

7-25.4.5 Loose edges may be trimmed, provided a one-inch minimum lap or seam is maintained.

7-25.4.6 The maximum number of heat applications permitted on the same repair is limited to four.

#### 7-25.5 REPAIR FOR NON-SELF-SEALING GOODYEAR (VITHANE) CELL.

7-25.5.1 Trim all loose or damaged fabric from the repair area with scissors. The damaged area shall be rounded to prevent further tearing of the cell.

7-25.5.2 Clean with solvent and tape cell surface approximately 12 inches beyond the damaged area.

7-25.5.3 Inside patch. Cut the patch from repair material (FT-227) large enough to cover the damaged area, and extend a minimum of one-inch from edge of damaged area in all direction, and round the corners of the patch. If outside patch is required, it shall be 1/2-inch larger than the inside patch.

7-25.5.4 Center the repair patch over the defect. Mark 1/2-inch beyond in all directions.

7-25.5.5 Abrade the cell surface surrounding the damaged (marked) area and the contact side of the patch with fine emery cloth to remove the gloss.

7-25.5.6 Clean the abraded area twice with a clean cloth that has been moistened with solvent.

7-25.5.7 Tape an eight by eight inch piece of release film over the defect on the outside of the cell.

#### 7-25.5.8 Cement Mixing and Application.

- a. Mix three-part cement (5923C) in accordance with manufacturer's instructions.
- b. Brush one even coat of repair cement on the abraded area of the cell to within 1/4-inch of edge and on the abraded side of the repair patch. Allow to dry 15 minutes.
- c. Apply a second coat of cement to repair as above. Allow the cement to dry five minutes.
- d. Patch Application. Center the inside patch over the damaged area. Lay the repair patch carefully by rolling action from center to edge to prevent trapping air. The repair patch may be moved by hand on wet surface by sliding to center over damaged area. Tape a piece of release film over the patch.
- e. Pressure Plates. Cover smooth surface of each of the two aluminum plates (plates must be larger than the cemented area) with fabric backed foam. Tape foam side to the plate. Foam must cover edges of plate for added protection.
- f. Sandwich the cell between the padded pressure plates.
- g. Apply a 240°F cure iron to the plate covering the repair patch. Secure the assembly with a "C" clamp. Tighten by hand. Wipe off excess cement that flows beyond the pressure plates.
- h. Plug the 240°F cure iron into the specified voltage electrical outlet. After two hours cure, unplug the electric repair iron and allow to cool to room temperature. Then remove the heating iron and plates. Remove the release film.
- i. Inspect edges of the patch for a complete seal. If loose edges are evident, re-cement patch area and recure as above.

7-25.5.9 Outside Patch Application. Use the same procedure as described for inside patch repair. Outside shall be 1/2-inch larger than the inside patch.

7-25.5.10 Air Cure Method. Follow the same procedures as the heat cure method except omit using the electric cure iron. Air cure each repair for a minimum of 72 hours, undisturbed, at 75°F.

7-25.5.11 Inspection. Vithane cells are to be tested the same as bladder type fuel cells.

#### 7-25.6 QUICK REPAIR OF URETHANE (GOODYEAR VITHANE) NON-SELF-SEALING FUEL CELLS.

7-25.6.1 GENERAL. This quick repair method is intended for repairing Vithane bladder (non-self-sealing) cells with minor damage without removing them from their cavities. The larger cells, Goodyear Vithane constructions BTC-49, 69, 69-1 and 86, can accommodate the repair without removal. The repair should not be attempted on smaller constructions such as Goodyear Vithane construction BTC-39 and 39-1.

7-25.6.2 Repair Limitations. Repairable defects applicable to quick repair are:

- a. Holes, punctures, and cuts - 1/2-inch maximum in any direction.
- b. Tears - one-inch maximum.
- c. Abraded areas or missing coating - two-inches diameter provided fabric is not damaged.
- d. Loose edges - trim looseness provided 1/2-inch lap is maintained.

#### 7-25.6.3 Surface Preparation.

- a. Cut fabric patch from fabric (3604N). Size the patch to extend one-inch beyond the damage in all directions.
- b. Wash the cell to twelve inches beyond the damage in all directions with solvent.
- c. Center the patch over the defect. Mark the cell 1 1/2-inch beyond the parameter of the patch.
- d. Abrade the marked cell area with fine emory cloth to remove the gloss.
- e. Wash the abraded area twice with a clean cloth using clean solvent.

#### 7-25.6.4 Patch Application.

- a. Mix the 82C32 cement. Mix the cement in accordance with the manufacturer's instructions or the following. Pour Part #2

into the container of Part #1 and stir with a tongue depressor stick approximately five minutes. Stir thoroughly making sure all Part #1 cement in the corners of the can is mixed with the Part #2 cement. Pot life is approximately 15 minutes.

- b. Apply one brush coat of 82C32 to the clean abraded area. Let dry 15 minutes. It is best to mix fresh cement for each coat. Apply second brush coat of 82C32. Let dry 15 minutes. Apply third coat of 82C32 cement.
- c. While the third coat of 82C32 cement is still wet, lay the 3604N fabric patch in the wet cement and smooth out with a brush, removing all entrapped air.
- d. Apply a final coat of 82C32 cement onto the 3604N fabric patch. Allow the repair to air cure for a minimum of six hours at a minimum temperature of 70°F before exposing repair to fuel.

#### 7-25.6.5 Inspection of Repair.

- a. Check repair after it has air cured for the specified time to assure cement is cured. Stickiness is an indication of undercure.
- b. Check edges of repair for looseness. Looseness up to 1/8-inch may be trimmed off.

#### 7-25.7 REPAIRING GOODYEAR VITHANE SELF-SEALING CELLS.

7-25.7.1 GENERAL. The self-sealing portion of Goodyear Vithane fuel cells (Goodyear FTL-102), consists of an outer wall of nylon fabric reinforcing plies, sealant material, barrier material, and a Vithane rubber inner liner. The self-sealing is constructed the same as the non self-sealing cells, except that sealant material FT-235 shall be used for repairs.

7-25.7.2 Type of Damages and Repairs. For damages and repairs, refer to paragraph 7-26.

7-25.7.3 Repair Limitations. For repair limitations, refer to paragraph 7-26.

7-25.7.4 Repair of Self-sealing Goodyear (Vithane) Cells. Self-sealing fabric shall be repaired the same as Goodyear Urethane (Vithane) non-self-sealing fuel cells, except that fabric repair material FT235 shall be used. Refer to paragraph 7-26.

#### 7-25.7.5 Preparation.

- a. Trim or cut away all defective material. The opening diameter should correspond to

the diameter of the self-sealing repair plug (FT236).

- b. Clean inside and outside cell surface with solvent and tape approximately 12 inches beyond the damaged area.
- c. Abrade cell surface surrounding the damage 1/4-inch beyond the repair plug flange (both inside and outside), and the contact surfaces of the repair plug. Use fine emory cloth to remove gloss.
- d. Clean abraded surfaces of cell and repair plug three times with a clean cloth, moistened with solvent. Use clean cloth for each operation.

7-25.7.6 Cement Mixing. Pour two-part 80C29 into container and mix thoroughly. May be used immediately.

7-25.7.7 Plug Insertion and Cement Application.

- a. Insert self-sealing repair plug FT-205 in cell with the stenciled side facing out. Push one flange of the plug through the hole and straighten the flanges so they lay flat on both the inside and outside of the repair area.
- b. Brush one coat of cement evenly on to the abraded contacting surfaces of the cell and the abraded flanges of the repair plug. Allow to dry for 15 minutes.
- c. Apply a second coat of repair cement and allow to dry for five minutes.
- d. Lay the plug flanges (one at a time), working out all trapped air to assure good contact.
- e. Tape a piece of release film over each repair plug flange.

7-25.7.8 Pressure Plates and Cure.

- a. Application and use of pressure plates and heat iron are the same as Goodyear Vithane non-self-sealing fuel cell (paragraph 7-26).
- b. Air Cure. Air cure method is the same as Goodyear Vithane non-self-sealing fuel cell (paragraph 7-26).

7-25.7.9 Fitting Repair. Replace fuel cell fitting in accordance with instructions contained in paragraph 7-10.

7-25.7.10 Self-Sealed Test. Vithane self-sealing fuel cell shall be leak-tested the same as bladder type fuel cell.

7-25.7.11 Cell Studs. For cell studs on Vithane self-sealing refer to TO 1F-15A-2-12.

7-26 CELLS REPAIRED BY AN APPROVED CONTRACTOR.

All repairs shall be in accordance with this TO and other contractual requirements. Repairs shall only be accomplished by approved sources. Replacement cells, other than those obtained from government stock, shall be obtained from a source approved by the contracting officer. When depot maintenance is performed by private industry the contractor representatives shall indicate (in writing) the qualified source of the cell repair.

7-27 FUEL CELL TESTING.

7-27.1 FUEL CELL FITTINGS.

7-27.1.1 All cells that have had the fitting sealing or O-ring surface repaired shall be tested after the repair is complete.

7-27.1.2 Materials Required. Plate, air source, manometer, hardware, detergent, water, emery paper, support fixture.

7-27.1.3 Procedures.

- a. Clean fitting and plate to ensure no foreign matter is present.
- b. Cover each fitting with a plate which has the same bolt pattern as the fitting.
- c. Install bolts and torque as specified in the aircraft technical manuals.
- d. One fitting shall be equipped with two connectors, one attached to the water manometer and the other to the air supply.
- e. Support the cell in a suitable fixture or jig.
- f. Inflate the cell to 0.75 psi. If external supports are not available inflate the cell to 0.25 psi maximum and use chemical test (paragraph 7-27.4).
- g. Mix a solution of one cup detergent and one gallon of water. Apply to edge of plate.
- h. Check for bubbles.
- i. If bubbles are noted, release pressure, remove plate, repeat test.
- j. If bubbles are still noted; release pressure, remove plate, lightly sand or replace fitting.

7-27.2 SELF-SEALING CELLS. Test in accordance with instructions provided by aircraft systems manager. In general the test should include a stand test for 24 hours, followed by draining and an internal inspection for sealant activation. Test

methods for bladder cells may indicate a no leak condition but may not detect defects which will cause activation of the self-sealing fabric.

7-27.3 BLADDER CELLS. Test bladder cells by using one or both of the following test procedures after repairs. Test requiring internal pressures may result in an indication of a false leak. Cells

found to produce this type of leak from seepage shall be pressurized to 1/4 to 1/2 psi, according to the table below and remain pressurized for up to 24 hours (generally six hours is sufficient). A fixture or jig is not required to support the cell for this test.

Table 7-1. Cell Test Pressure

<u>CAPACITY</u>	<u>AIR PRESSURE</u>	<u>WATER MANOMETER</u>
0 - 1000 GALLONS	1/2 PSI	14 INCHES
1000 GALLONS AND UP	1/4 PSI	7 INCHES
ALL VITHANE CELLS	1/4 PSI	7 INCHES

7-27.4 CHEMICAL TEST.

7-27.4.1 Materials required. Silver pencil, plate, air source, hardware, ammonium hydroxide, absorbent cloth, white cloth (cheese cloth or bed sheet), 100cc measure, 200cc measure, 2-quart measure, 15 gram measure, gaseous ammonium, water, phenolphthalein crystals, alcohol, solvent (MEK, MIBK, or MIL-C-38736).

7-27.4.2 Procedures.

- a. Remove all red colored marks from cell. Red marks may give false indication of a leak.
- b. Locally fabricate a plate with two inlet fittings to fit any one of the fittings in the cell; one for the air inlet and the other for the water manometer. As an alternate fabricate a plate with three inlet fittings, two for air inlets and the third for the water manometer.
- c. Attach cover plates to all openings except the access door. Torque to value specified in the aircraft system manuals.
- d. Install the inlet fitting and tighten the cover.
- e. Pour ammonium hydroxide on absorbent cloth (100cc for tanks less than 1000 gallons, 200cc for all other capacity tanks.) As an alternate method use gaseous ammonium without the absorbent cloth. Develop local procedures to meter the gas.
- f. Place cloth in tank.
- g. Install access door cover plate and inflate cell. (Refer to Table 7-1).
- h. Prepare leak detection mixture. Mix 15 grams phenolphthalein crystals into two quarts of water, then add two quarts of alcohol.

- i. Soak a large white cloth in solution, wring thoroughly.
- j. Spread cloth over cell and smooth down to ensure detection of minute leaks.
- k. Check for red spots. Due to a chemical reaction the moistened cloth will develop red spots when in contact with the ammonium. Red spots can be removed by resoaking the cloth.
- l. Mark leaks as necessary
- m. Move cloth and repeat procedure to check entire surface
- n. The solution and test cloth remain usable as long as they remain clean. Store excess solution in a closed container to prevent evaporation and deterioration.
- o. Remove all cover plates, equipment. Clean all metal surfaces with solvent to prevent corrosion. Do not enter cell until a proper purge has been established.

7-27.5 SOAP SUDS TEST.

7-27.5.1 Materials required. Water, soap (7930-00-282-9699), cover plates, air source, air inlet fitting, silver pencil.

7-27.5.2 Procedures.

- a. Locally fabricate an air inlet fitting to fit any fitting on cell.
- b. Attach cover plates and air inlet fitting. Torque to value specified in the aircraft system manuals.
- c. Inflate cell to proper pressure.
- d. Mix one cup of soap and one gallon of warm water.

- e. Apply solution to repaired areas or areas suspected of leaking. Check for bubbles.
- f. Mark all leaks.
- g. Remove all cover plates, equipment. Wash soap residue from cell and dry. Do not enter cell until a proper purge has been established.

#### 7-28 LACQUER FINISH COAT.

7-28.1 An exterior lacquer finish coat is optional except when specified by aircraft systems managers or specific manuals.

7-28.2 Material Required. Buna Vinylite lacquer, brush, lacquer solvent.

7-28.3 Procedures.

7-28.3.1 Clean and dry (refer to 7-6.3) all surfaces to be coated.

7-28.3.2 Moderately thin lacquer if necessary.

7-28.3.3 Apply one coat by brush and allow to dry. Do not apply lacquer to fittings.

#### 7-29 FUEL CELL INSTALLATION.

7-29.1 All fuel cells shall be inspected and tested prior to installation. When cells are repaired or replaced in an aircraft, the cell part number, location in the aircraft, and date of installation shall be recorded on the applicable AFTO Form 95.

7-29.2 Materials required. Solvent (MEK, MIBK, MIL-C-38736), absorbent lint-free cloth, non-metallic scraper, cement, lacing cord, alcohol lamp.

#### 7-29.3 PREPARING FUEL CELL CAVITY FOR CELL INSTALLATION.

7-29.3.1 Inspect all cell fitting mating surfaces and connections for cracks, scratches, distortions, dirt, paint, grease or other damage which could cause a leak. Clean with solvent and scraper, repair or replace as necessary.

7-29.3.2 Inspect backing boards for cracks, chipping, crazing, or other damage which might damage the fuel cell. Replace backing boards as necessary.

7-29.3.3 Inspect cell attaching points for damage or missing hardware. Repair or replace as necessary.

7-29.3.4 Assure all vent or interconnect lines are in their proper positions and hose clamps are in position and accessible.

7-29.3.5 Inspect cavity for nicks, burrs, sharp edges, etc., which could damage the cell. Smooth

areas in accordance with the aircraft systems technical manual.

7-29.3.6 Inspect cavity for corrosion. Treat corrosion in accordance with TO 1-1-691.

7-29.3.7 Remove all dirt, grease and other foreign matter from cell cavity.

7-29.4 UNCRATING FUEL CELLS. Self-sealing cells are shipped in the normal positions. Four-sided or band-type cells are collapsed flat and folded over. Bladder cells are collapsed and folded into small packages. Open all crates in accordance with instruction on container. Open container in a clean area with a smooth surface.

#### 7-29.5 CELL PREPARATION AND O-RING INSTALLATION.

7-29.5.1 Unfold cell. Ensure cell temperature is 65 degrees.

7-29.5.2 Obtain O-rings, ensure compliance with time standards in AFM 67-1, VOL 7, PART 3. New O-rings shall be used whenever possible.

7-29.5.3 Inspect O-ring groove on fitting for damage or foreign material.

7-29.5.4 Clean O-ring groove with solvent.

7-29.5.5 Inspect O-ring for nicks, cuts or other damage.

7-29.5.6 Install O-ring. If O-ring will not stay in place apply a small amount of petrolatum to the lower surface of the O-ring groove and O-ring.

7-29.5.7 Remove all tags, stickers, tapes, protective devices from cell.

7-29.5.8 Ensure fittings are clean.

7-29.5.9 Fold cell. Ensure cell temperature is a minimum of 65 degrees for a bladder cell and 70 degrees for self-sealing cells.

#### 7-29.6 CELL INSTALLATION.

7-29.6.1 Ease cell into cavity.

7-29.6.2 Attach cell to aircraft structure in accordance with aircraft system technical manual. Vithane cells stored for extended periods or dry, low humidity will shrink in overall size. This condition will make the cell hard to install due to misalignment of cell fittings with mating surfaces. If this occurs the cell can be restored by soaking in warm water (120°F) for two to four hours (longer if necessary). As an alternate to the water soak, if difficulty is encountered during installation, cloths soaked in warm water should be placed on exposed, interior portions of the cell. Wet cloths as often as necessary.

7-29.6.3 Align cell fittings and interconnects. On fittings which use O-rings seat the O-ring so as not to pinch it between the fitting surfaces. Some fittings require the use of clamping rings to hold the fitting together and the O-ring in its groove (refer to aircraft systems technical manuals).

7-29.6.4 Install proper hardware and torque to value specified in aircraft systems technical manual.

7-29.7 LACING CORDS AND KNOTS. Many cells use lacing cords to secure stiffeners, fuel lines, and components in place. Figure 7-33 illustrates the proper method for preparing the ends of the lacing cord. Figure 7-34 illustrated the proper method for tying knots in the lacing cords.

#### 7-29.8 CELL CLOSING.

7-29.8.1 Clean entire interior surface using sponge or cheesecloth moistened in water. Ensure all lint and other foreign matter is removed.

7-29.8.2 Inspect cell interior for damage.

7-29.8.3 Install cell opening cover and torque bolts to value specified in aircraft systems technical manual.

7-29.8.4 Install cell cavity closure and torque bolts to value specified in aircraft systems technical manual.

#### 7-29.9 CELL FITTING TORQUE PROCEDURES.

7-29.9.1 To prevent damage to the cell fittings and adjacent structures ensure only bolts of the proper length are used. Torque bolts to the value specified in the aircraft systems manual. Bolt torque patterns are as shown in Figure 7-32. Once a torque pattern is established the same pattern must be adhered to.

7-29.9.2 Molded rubber fittings commonly used for self-sealing cells. These fittings use "cold flow" pressure (rubber is forced from a high pressure area to a low pressure area). Final tightening is accomplished two hours after initial torque is applied.

7-29.9.3 Compression fittings are commonly used in die-cut cells. Screws used to secure the aluminum halves of the fitting are usually torqued to 10 inch-pounds.

#### 7-30 FUEL CELL DOCUMENTATION.

7-30.1 All Fuel cells shall be inspected and tested prior to installation. When cells are replaced in an aircraft the cell location/position, date of installation, serial number, part number, manufacturer's name and date of manufacture shall be recorded on applicable AFTO Form 95.

7-30.2 When fuel cells are repaired prior to installation, the repair source and date of repair shall also be recorded on the AFTO Form 95. This AFTO Form 95 shall be maintained in the shop historical files until the cell is removed from the aircraft, at which time the form will accompany the cell.

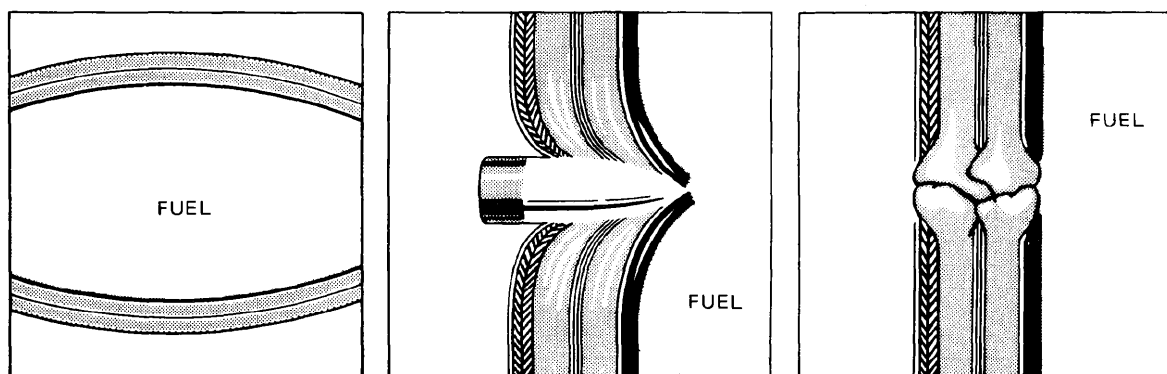


Figure 7-1. Projectile Sealing Action

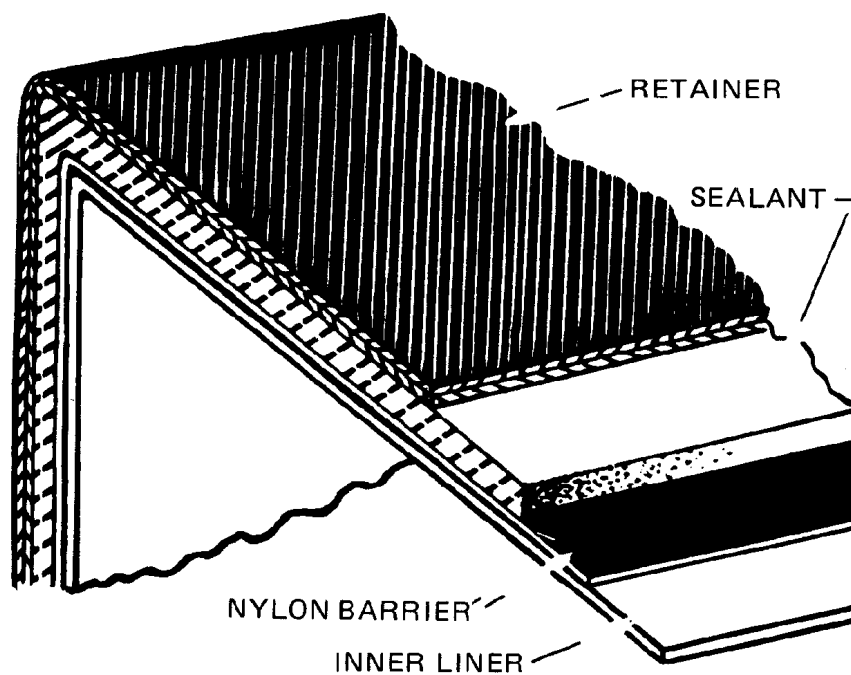
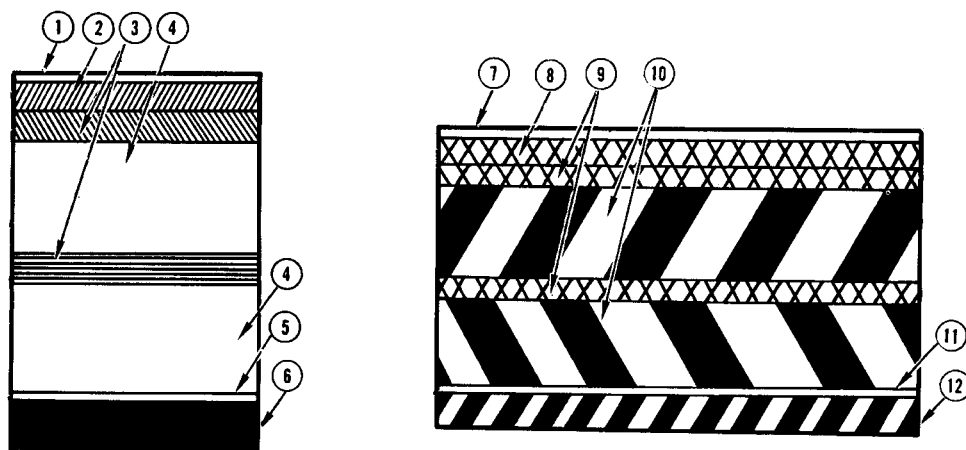


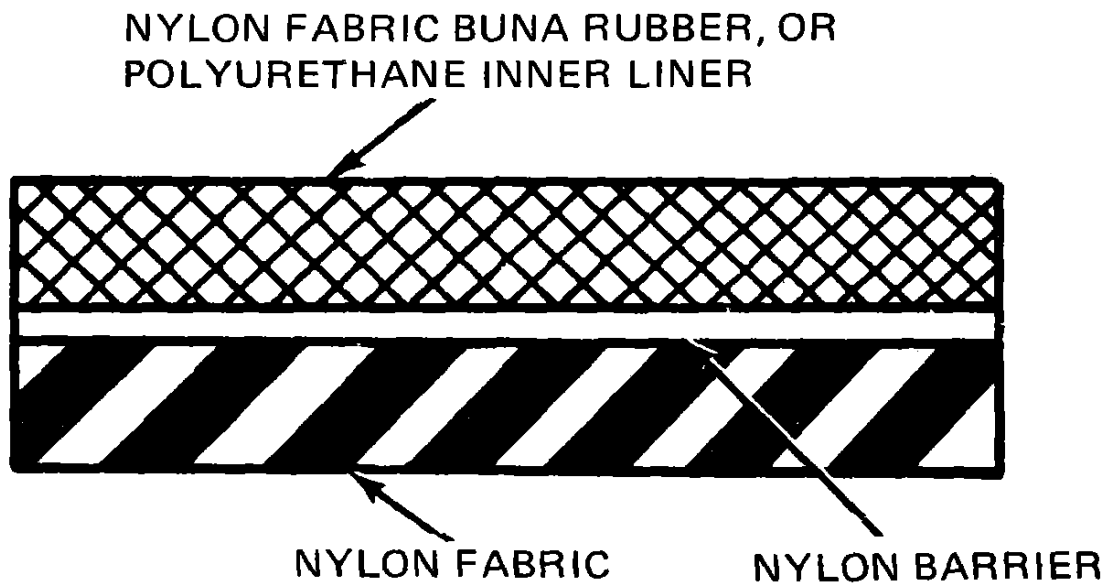
Figure 7-2. Fuel Cell Section



- 1 BUNA VINYLITE LACQUER
- 2 NYLON FABRIC
- OUTSIDE SKIM: BUNA
- INSIDE SKIM: RUBBER
- 3 CORD RUBBER COATED
- 4 SEALANT
- 5 NYLON BARRIER
- 6 BUNA RUBBER COATED FABRIC, OR POLYURETHANE INNER LINER

- 7 VINYLITE LACQUER
- 8 NYLON FABRIC
- 9 NYLON FABRIC
- 10 SEALANT NAT CRUDE (100%)
- 11 NYLON BARRIER
- 12 HYCAR LINER

Figure 7-3. Typical Self-Sealing Construction



### STANDARD BLADDER CELL NON-SELF-SEALING

Figure 7-4. Non-Self-Sealing Construction

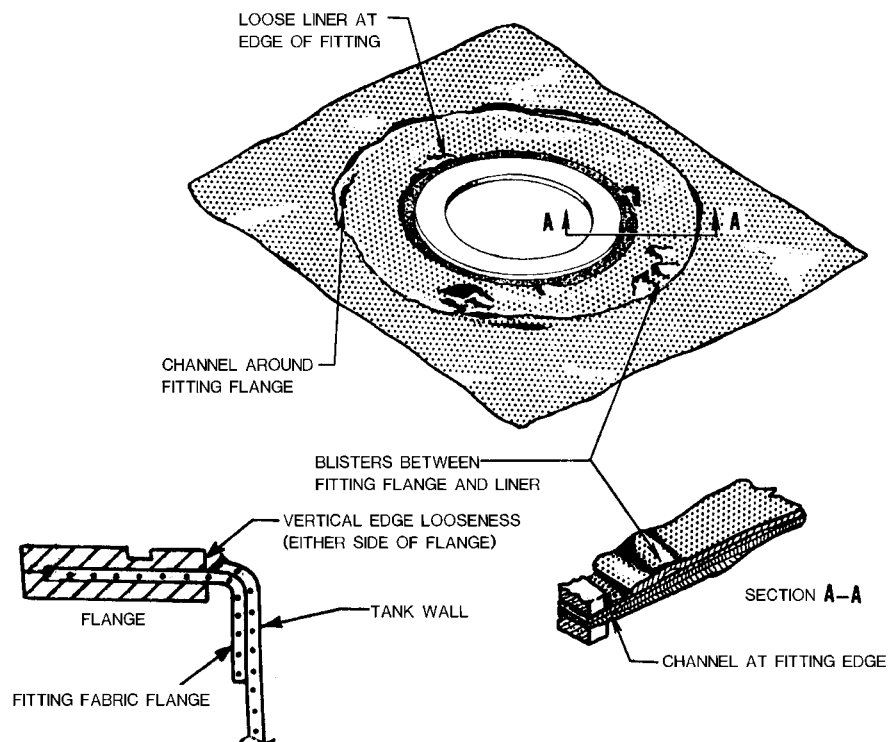


Figure 7-5. Channel Blisters and Loose Areas

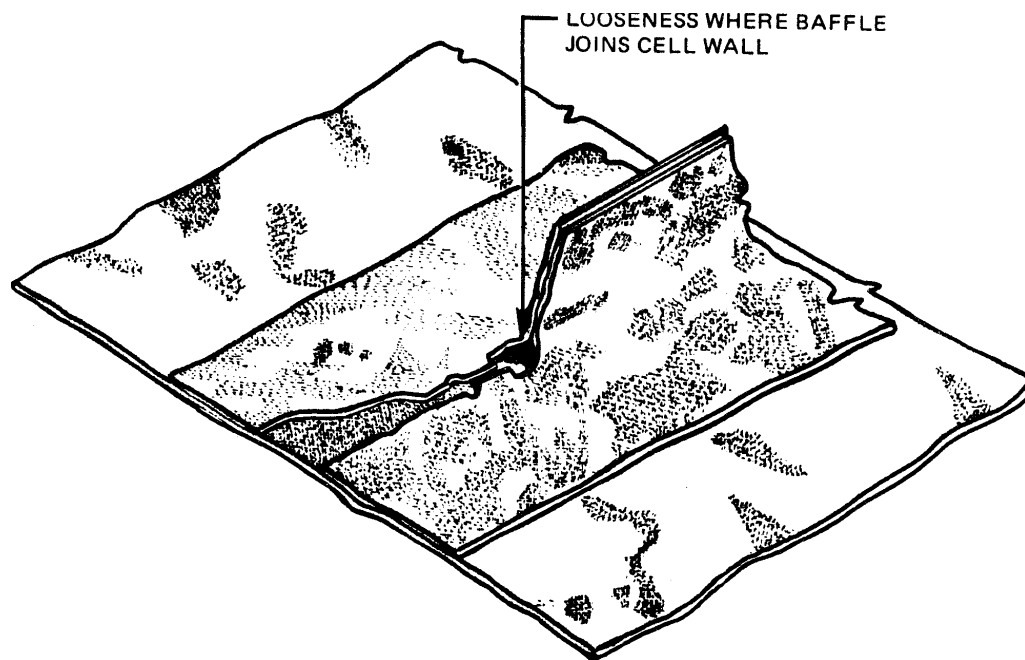


Figure 7-6. Loose Baffles

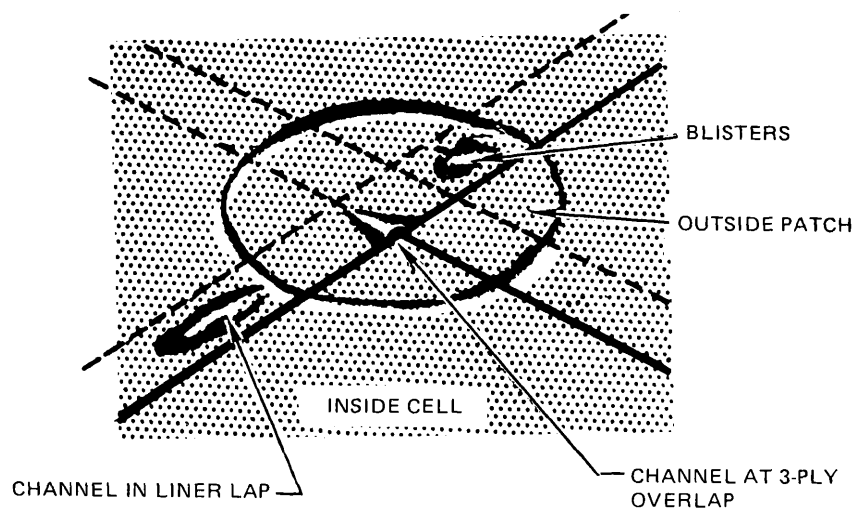


Figure 7-7. Loose Patches

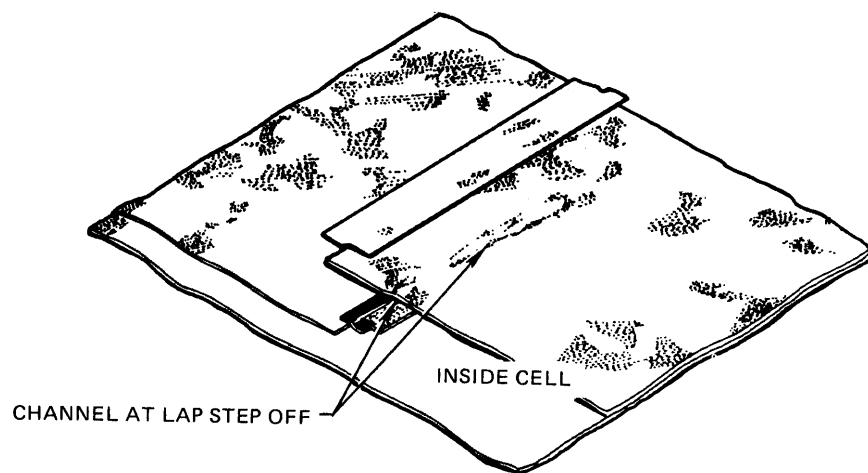


Figure 7-8. Channel at Lap Steps

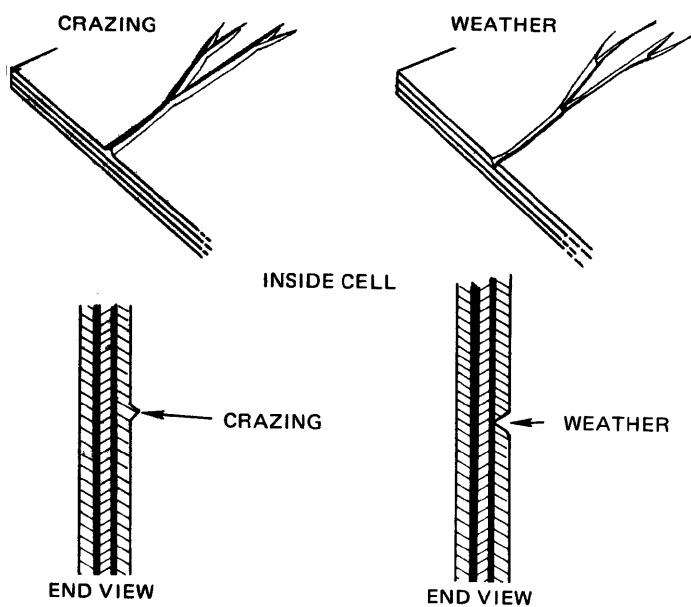


Figure 7-9. Weather and Crazing

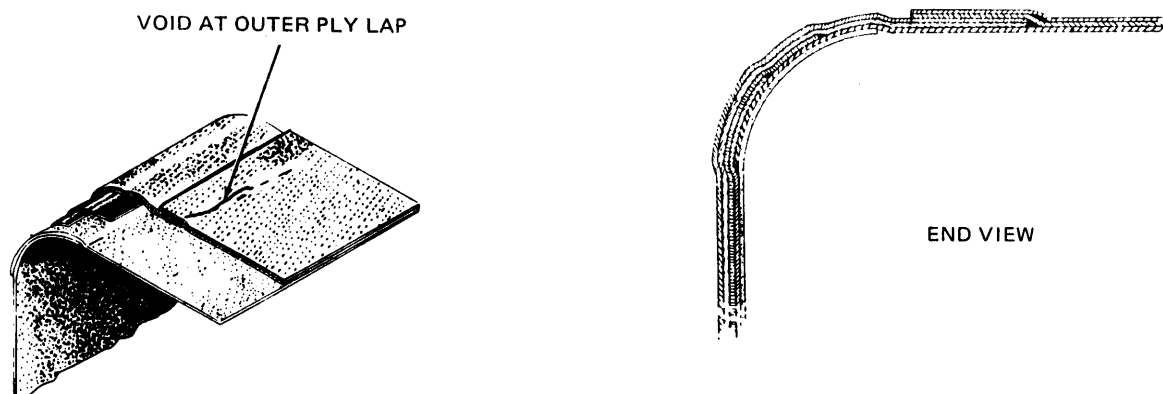


Figure 7-10. Lap Channels

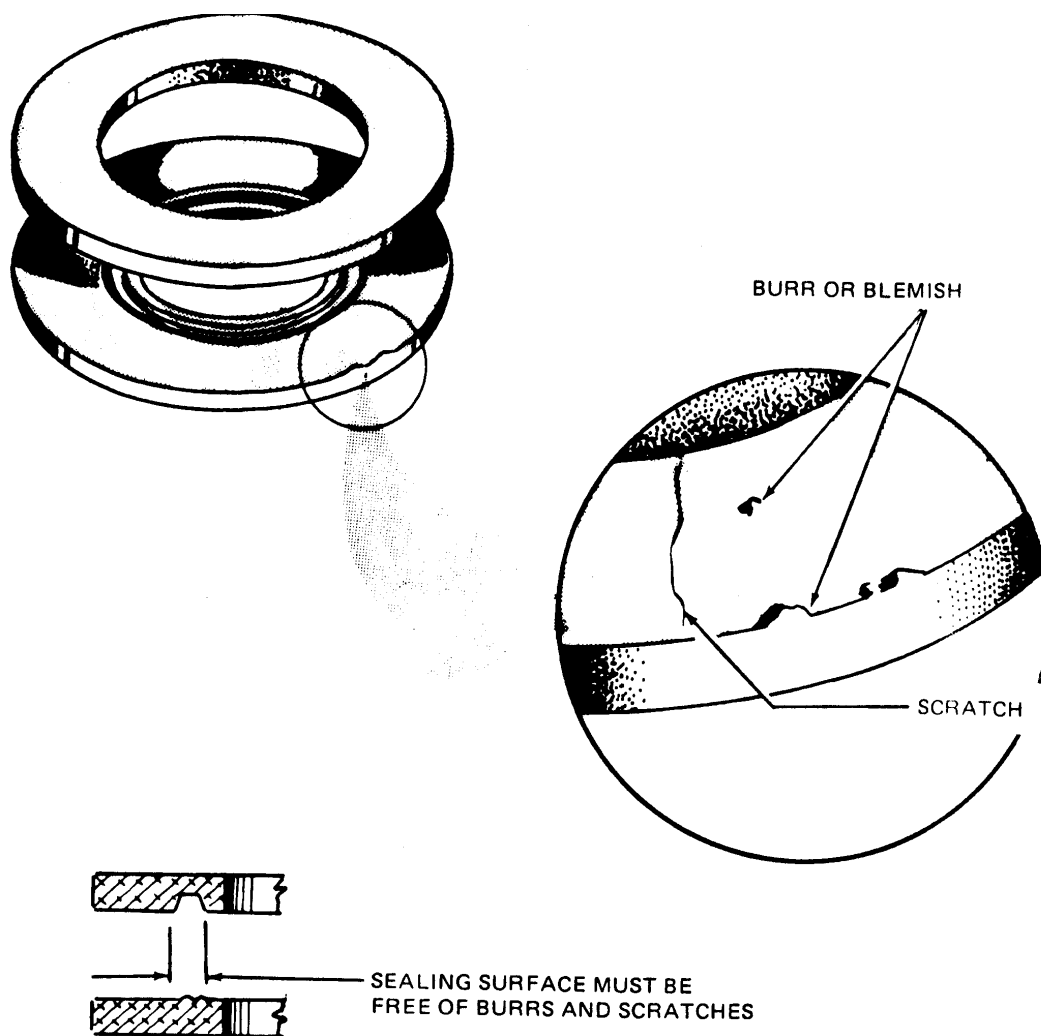
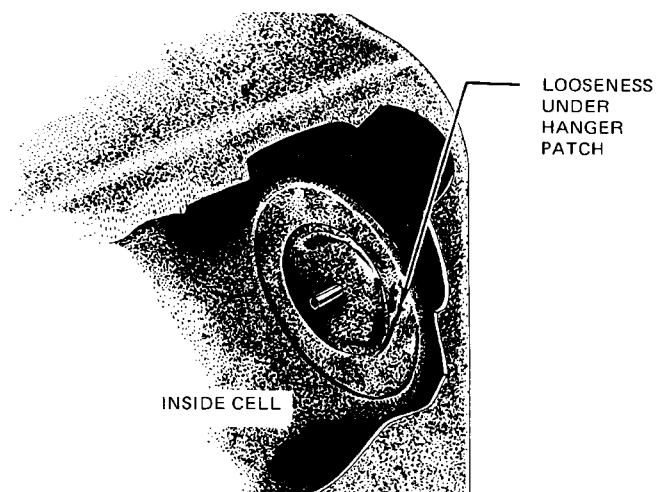
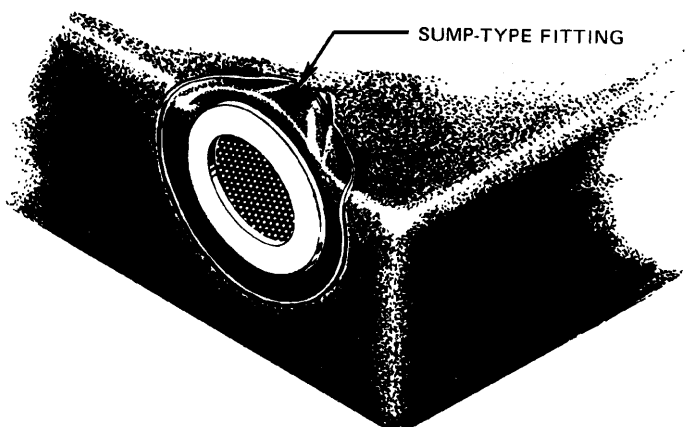


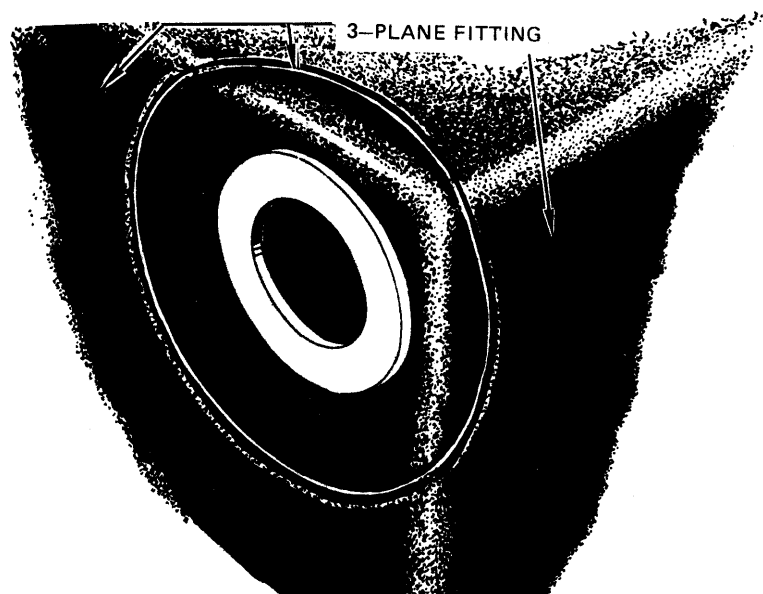
Figure 7-11. O-Ring Fitting Inspection



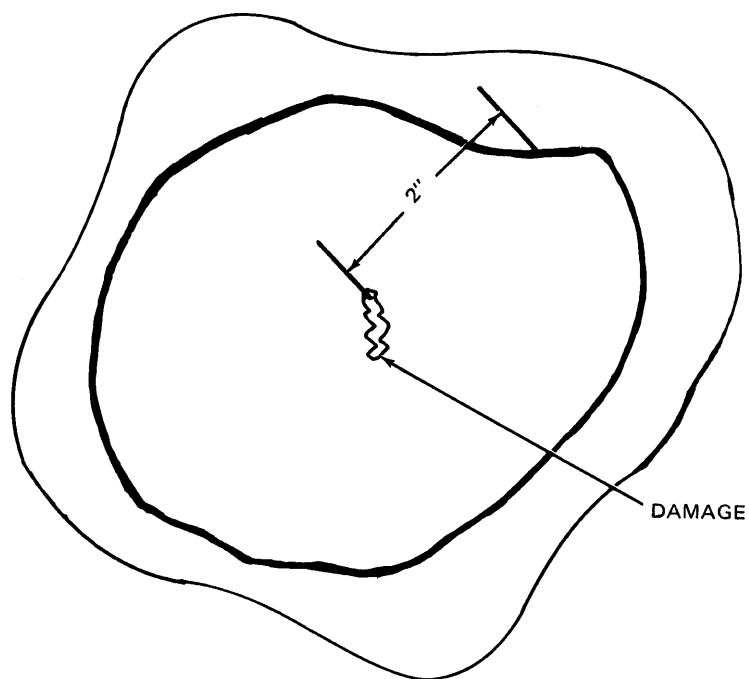
*Figure 7-12. Looseness Under Hanger Fitting*



*Figure 7-13. Sump Fitting*



*Figure 7-14. Three-Plane Fitting*



*Figure 7-15. Marking Area to Be Repaired*

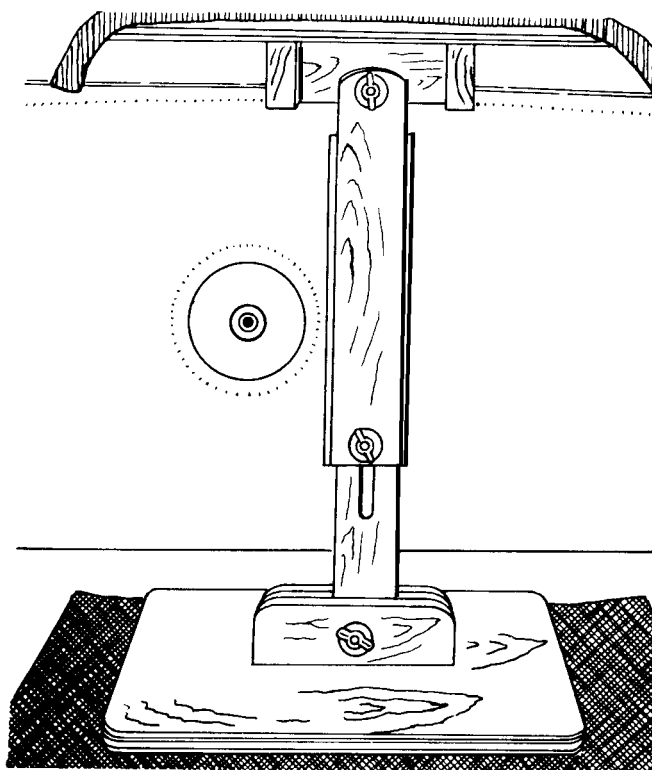


Figure 7-16. Pedestal for Supporting Cells

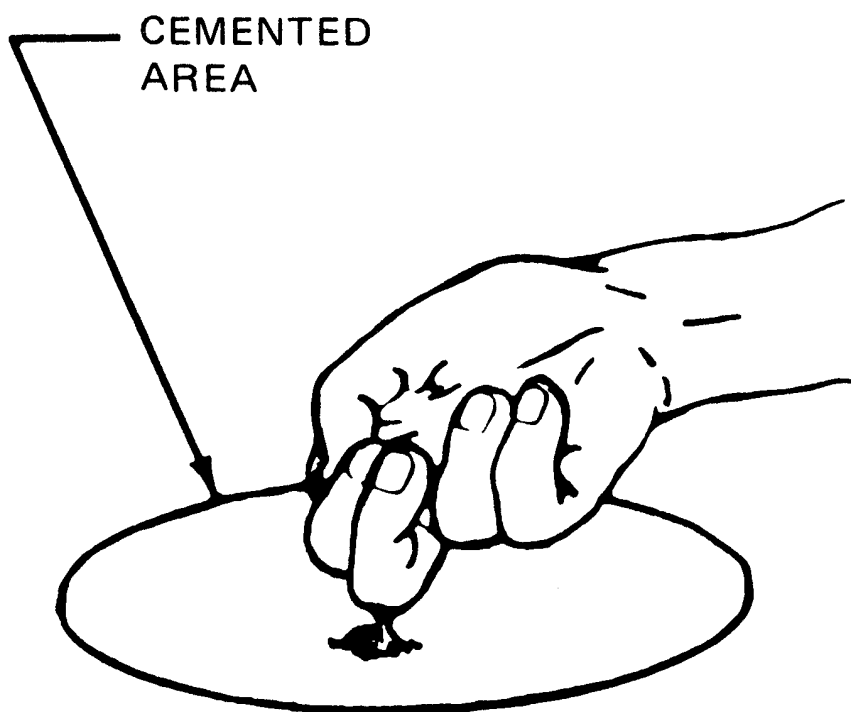
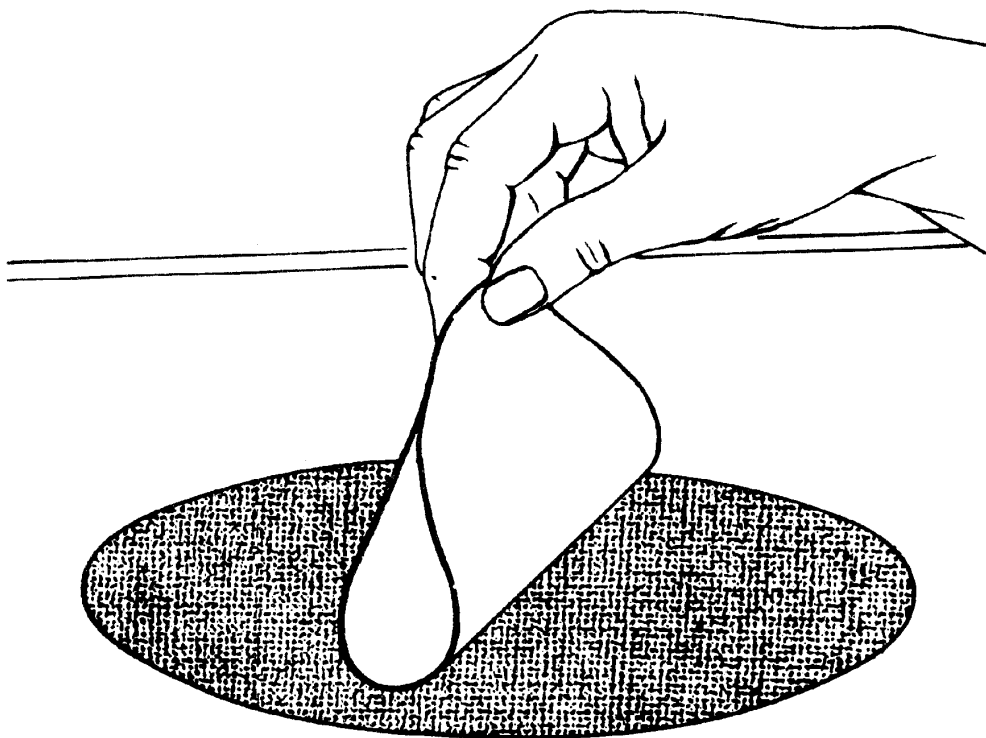
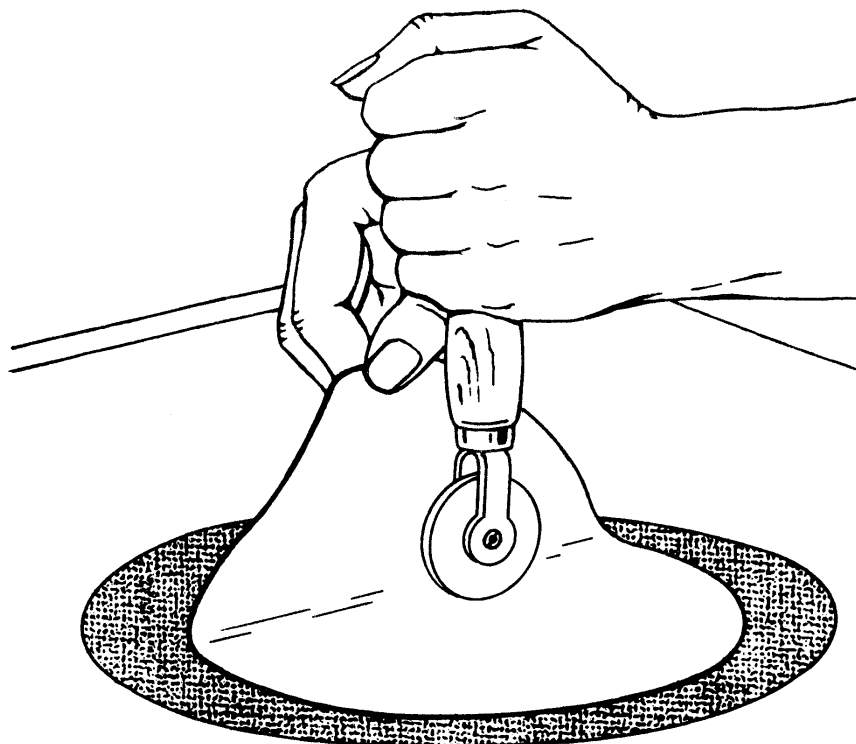


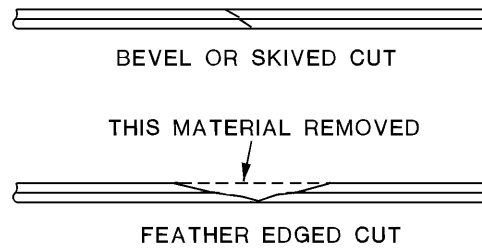
Figure 7-17. Knuckle Test



*Figure 7-18. Centering Patch*



*Figure 7-19. Rolling Down Patch*



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*Figure 7-20. Sectional Views of Corner Patch*

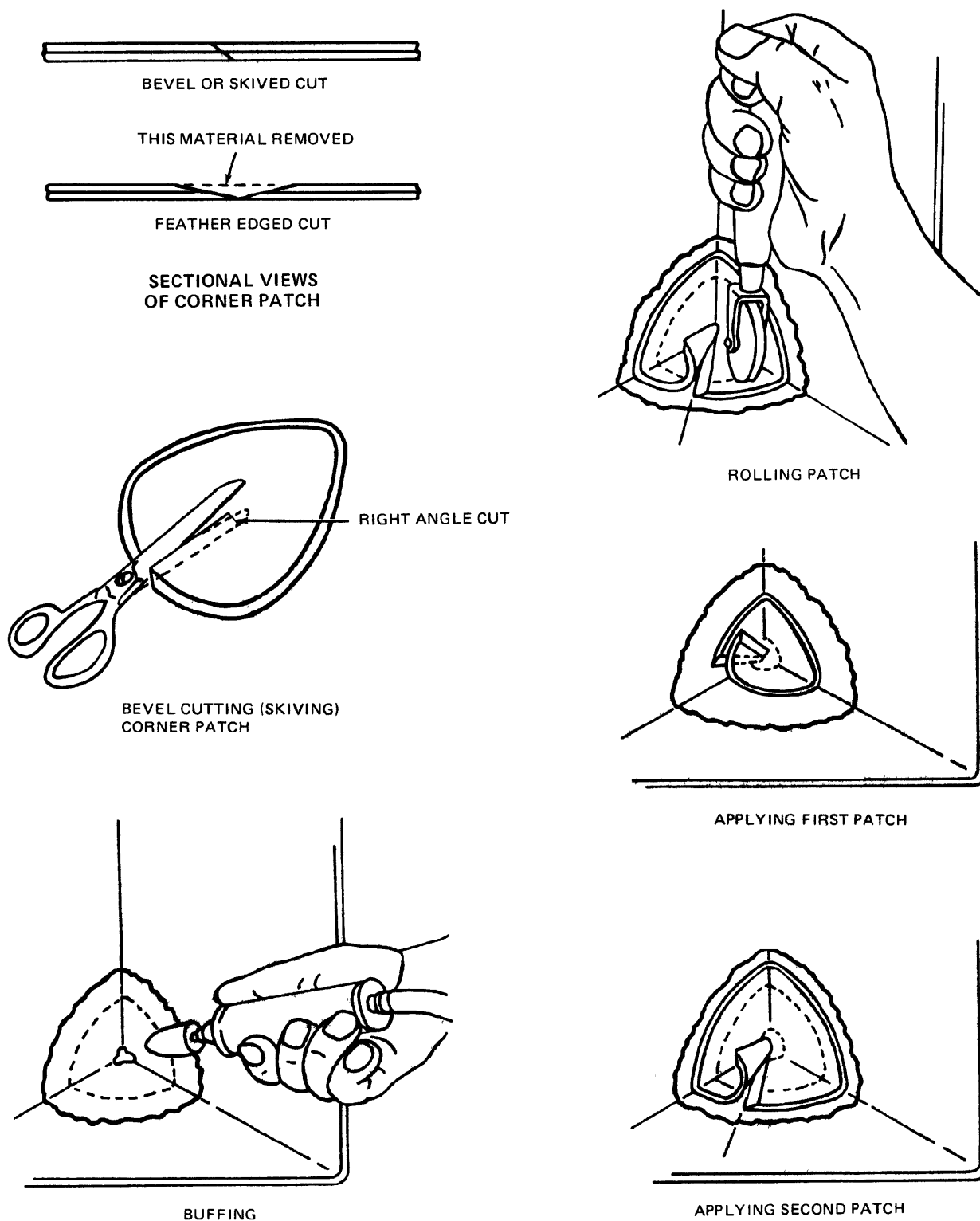


Figure 7-21. Inside Corner Repair

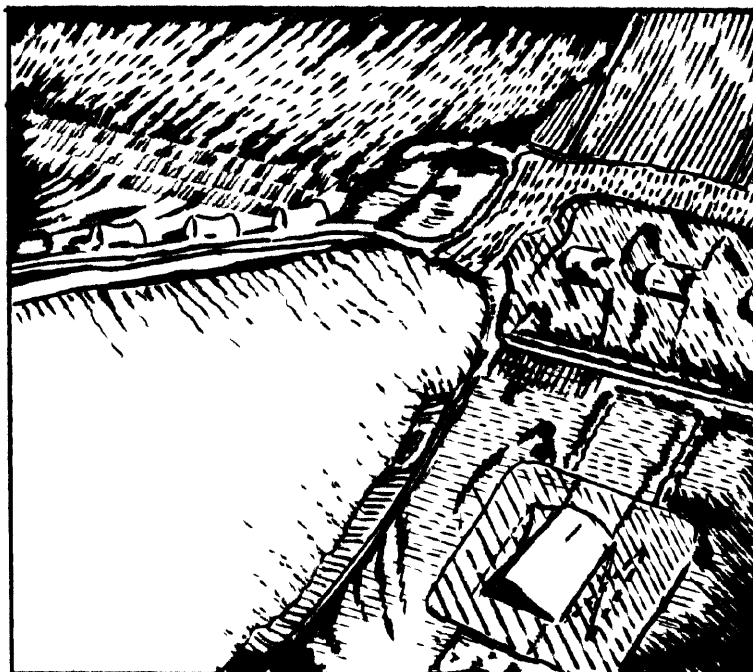


Figure 7-22. Ruptured Inner Liner

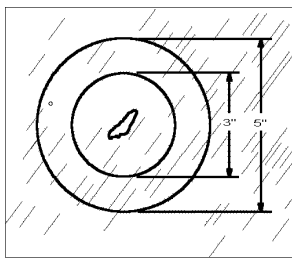


Figure 7-23. Marking Cell

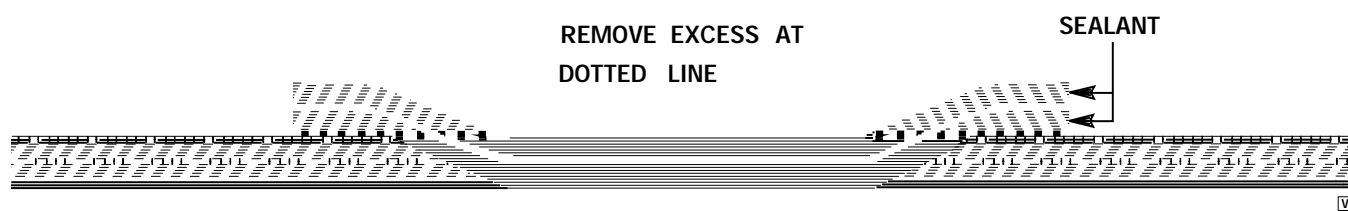
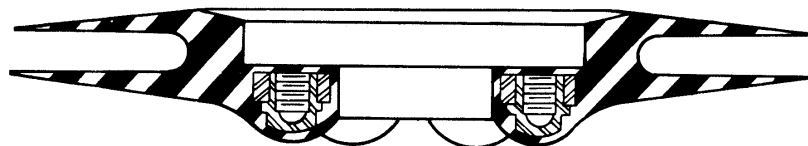
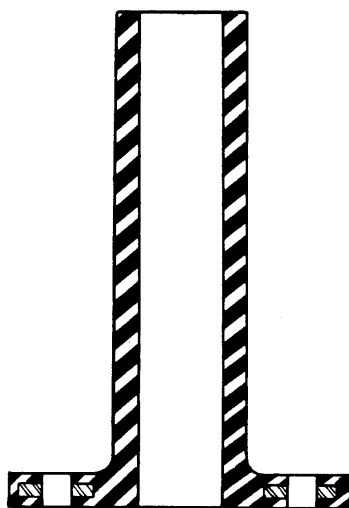


Figure 7-24. Built-up Cell



*Figure 7-25. Finished Built-Up Cell*



*Figure 7-26. Two-Piece Fitting*

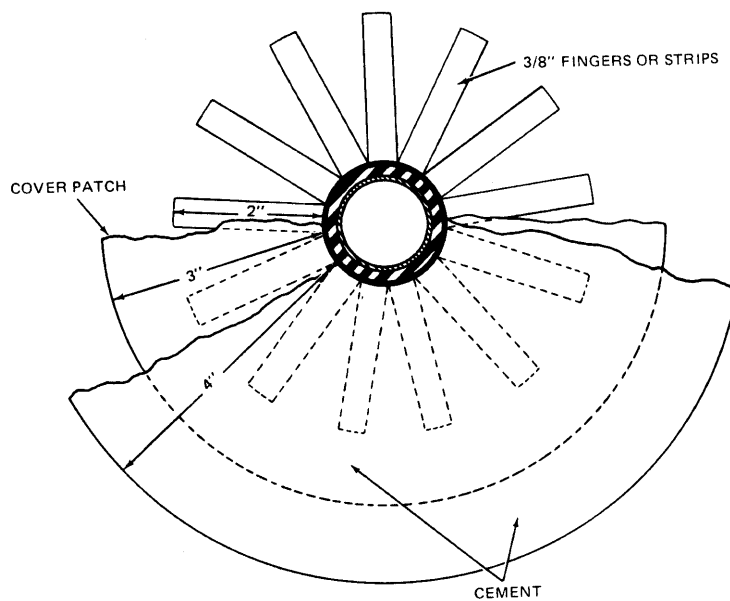


Figure 7-27. Wrap Application

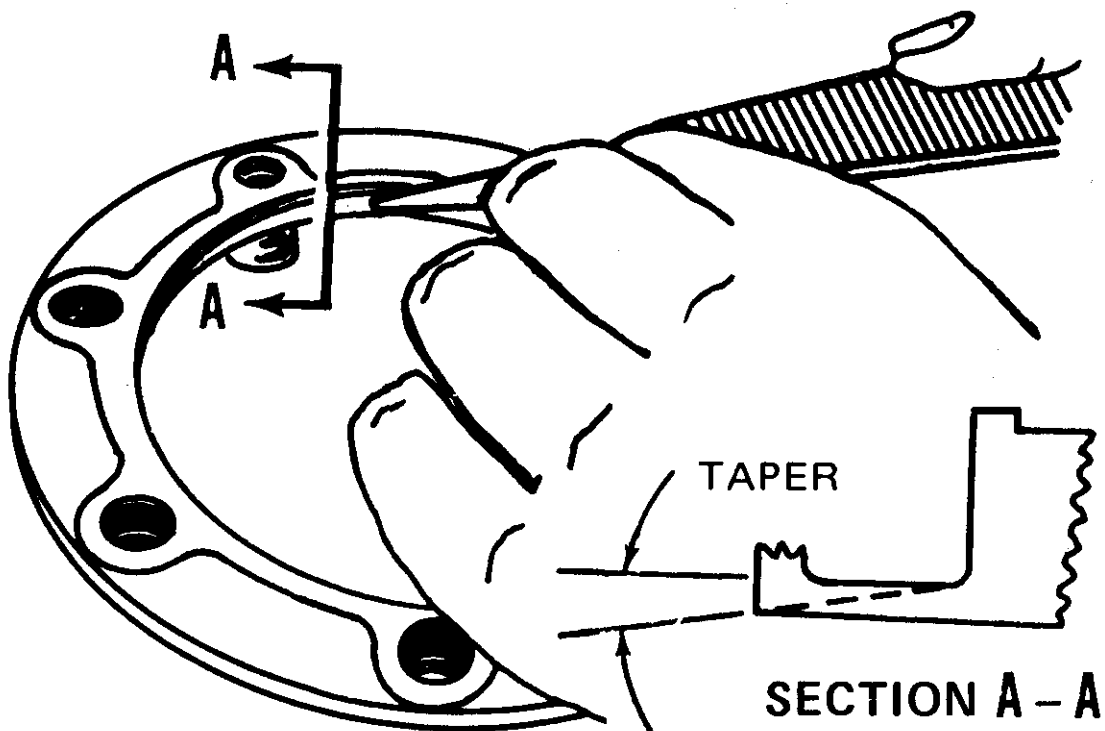


Figure 7-28. Fitting Flange Break

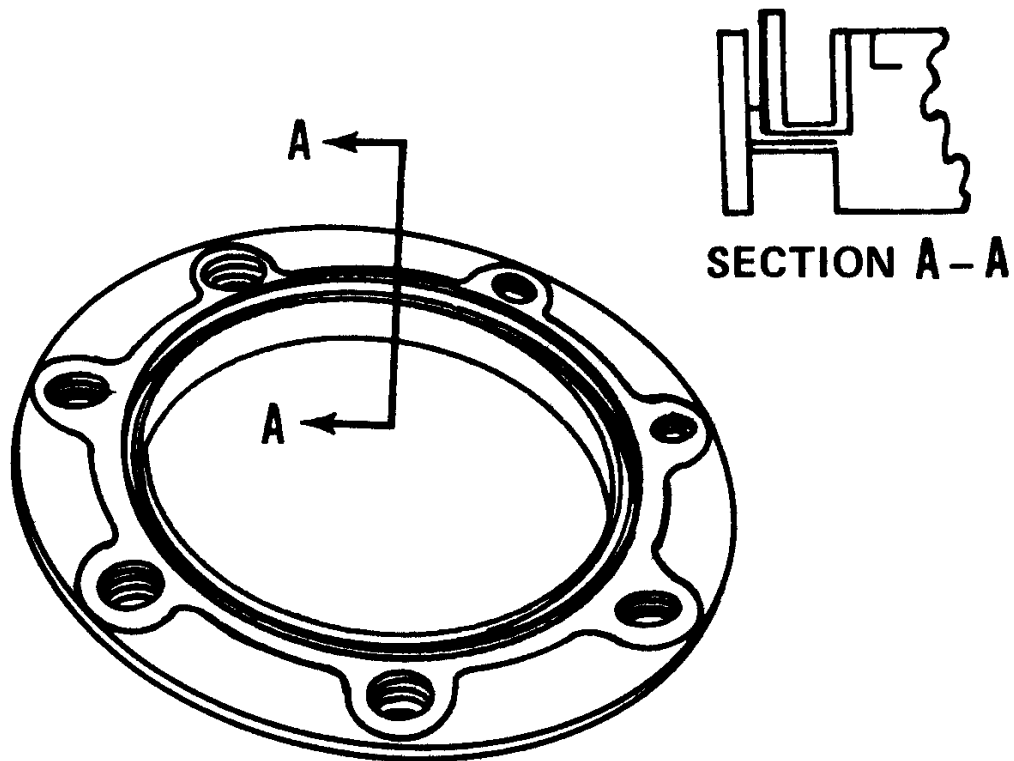


Figure 7-29. Retainer Ring Installation

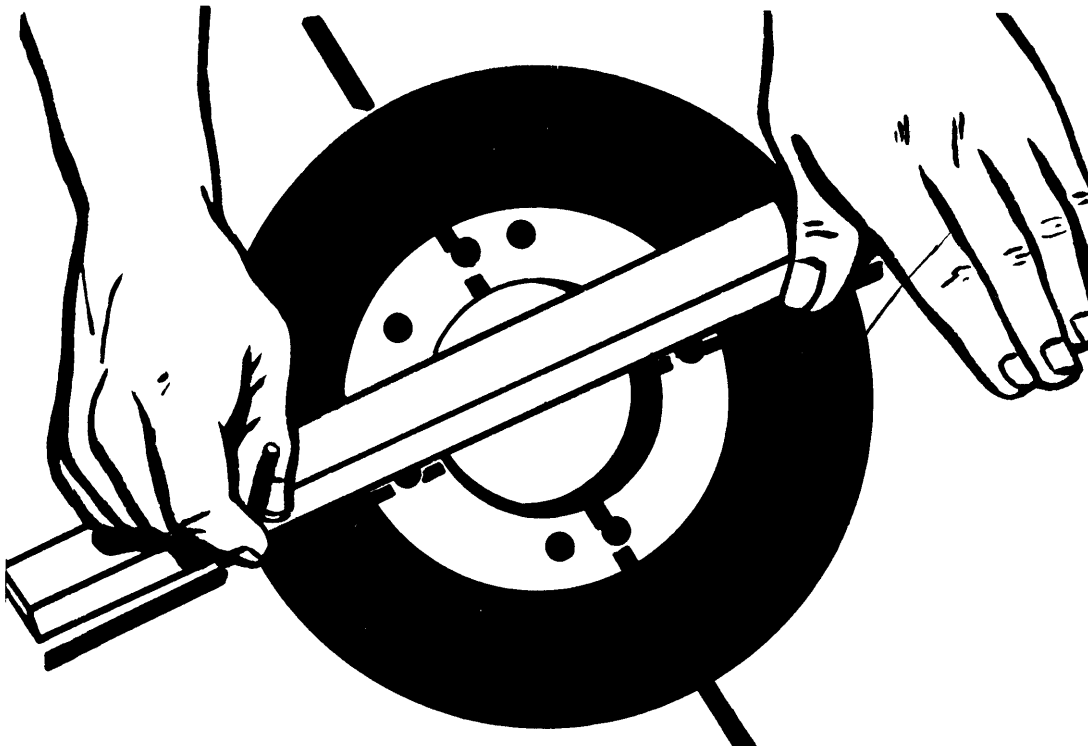


Figure 7-30. Locating Fitting

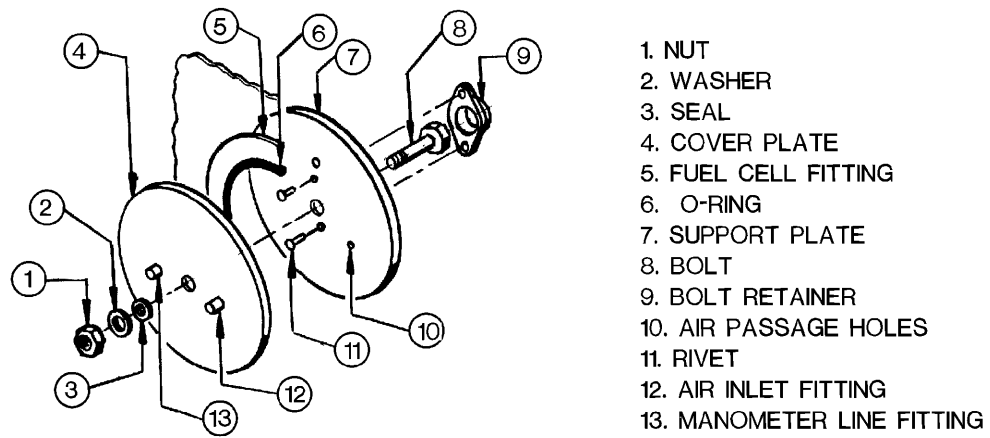
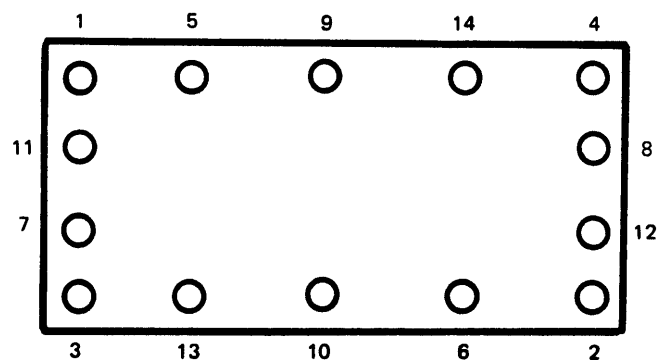
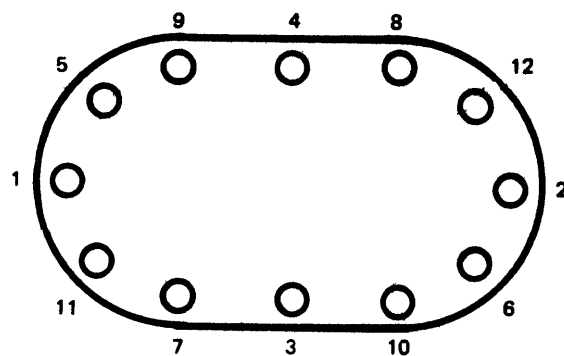
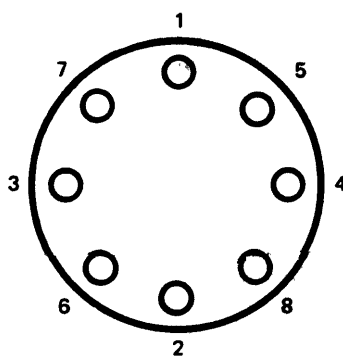


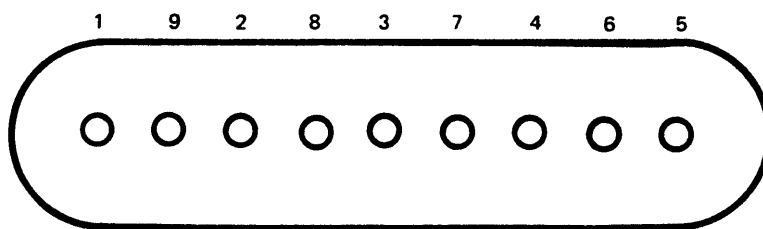
Figure 7-31. Fuel Cell Fitting Leak Test Cover Plate



RECTANGULAR OR SQUARE FITTINGS



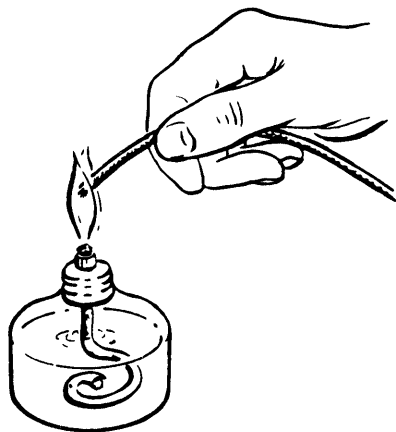
ROUND OR OVAL FITTINGS



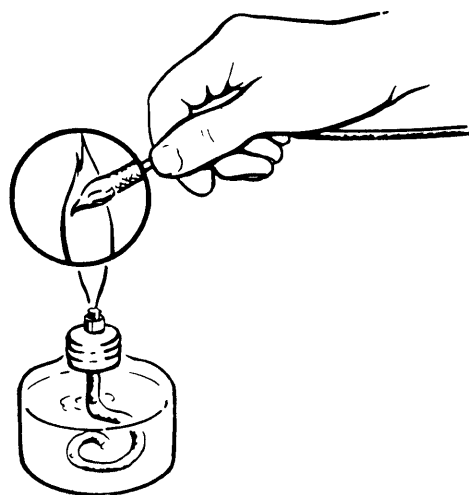
STRAIGHT FITTINGS

ONCE THE PATTERN IS ESTABLISHED, THE SEQUENCE MUST BE ADHERED TO

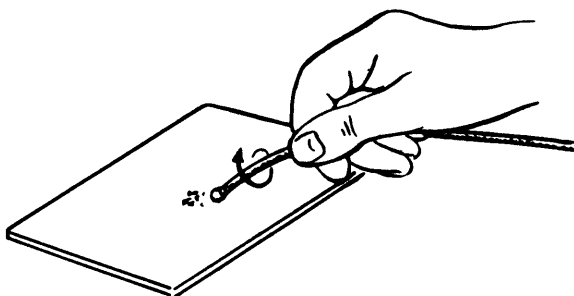
Figure 7-32. Torque Pattern for Bolts



1 MELT END OF NEW LINE UNTIL NYLON BEGINS TO BURN



3 REMOVE SHARP TIP BY REHEATING MOMENTARILY IN FLAME

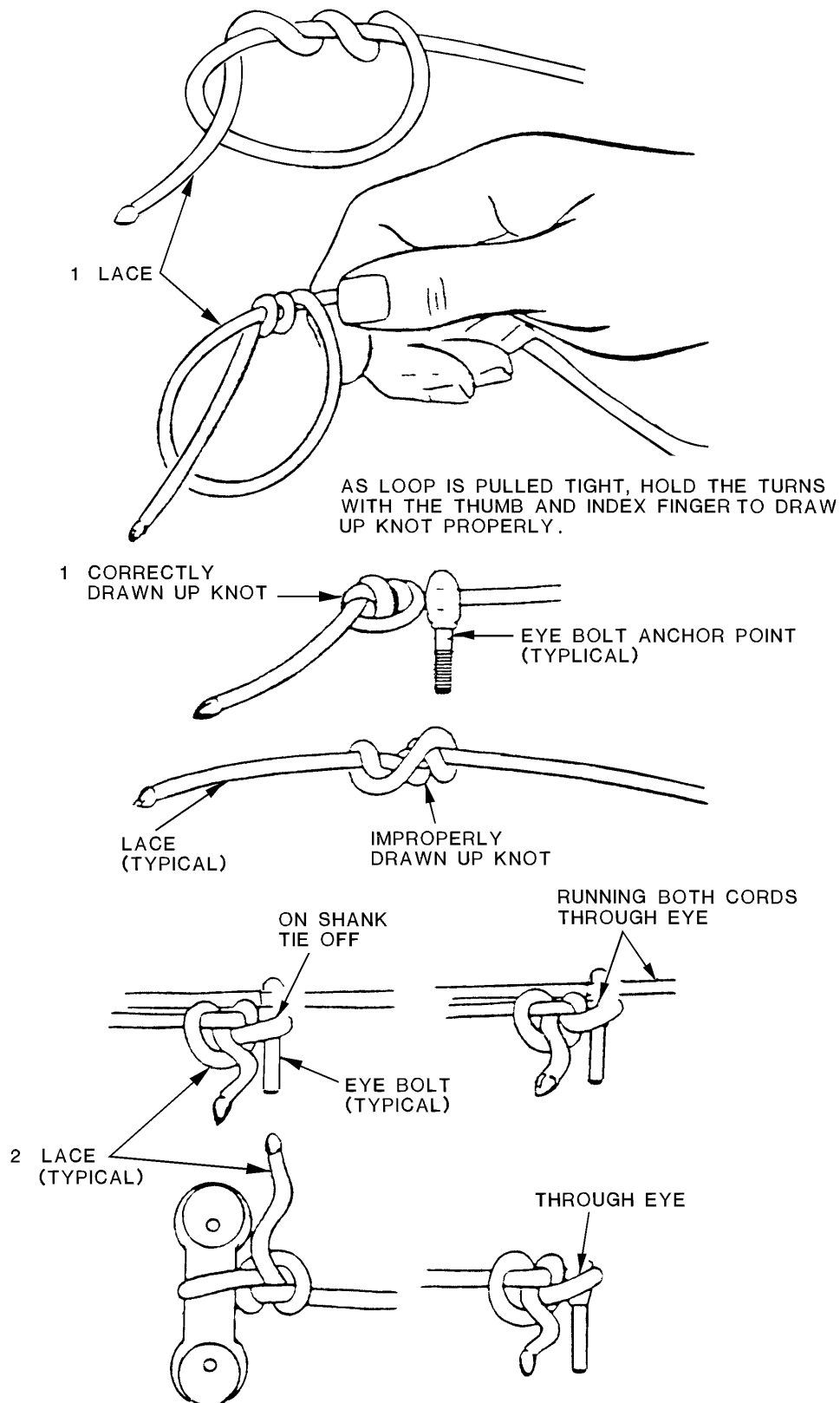


2 ROLL MELTED END ON CARDBOARD OR ANY FLAT SURFACE TO REMOVE EXCESS NYLON AND TO FORM SHARP TIP ON END OF LINE



4 ROUNDED END OF LACING LINE PROPERLY PREPARED FOR USE

Figure 7-33. Replacing Lacing Cords



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Figure 7-34. Lacing Cord Knots

## SECTION VIII

### EQUIPMENT AND MATERIALS

#### 8-1 PURPOSE.

8-1.1 This section contains information on selected equipment and materials needed to accomplish integral tank and cell repair using instructions provided in this manual.

#### 8-2 GENERAL.

8-2.1 The equipment and material listed in this manual are not the only products available but they have been proven to perform satisfactorily. This section contains a brief description of many of the products.

8-2.2 A table containing selected information on each product is included in this section as Table 8-1.

#### 8-3 EQUIPMENT AND MATERIAL SUBSTITUTION.

8-3.1 Proper equipment and material selection requires review and analysis of many criteria before a product can be approved for use. These criteria include but are not limited to: material interactions, environmental considerations, safety considerations, health considerations, and cost.

8-3.2 Equipment and materials shall not be substituted without proper authorization. Improper material selection has been proven to cause problems ranging from corrosion to adhesive bond failure. The use of improper equipment can create a safety hazard, an environmental hazard, or could damage the aircraft. The MAJCOM Functional Manager for Aircraft Fuel Systems, Weapon Systems Managers, and the Office of Primary Responsibility (OPR) for this technical order are the only organizations approved for authorizing substitutions for equipment and material required by this manual. The MAJCOM Functional Manager for Aircraft Fuel Systems, Weapon Systems Managers, and the OPR for this technical order should work together and advise each other of newly approved equipment and materials. Local and MAJCOM Environmental Management, BES, Fire Department, and Safety Offices may prohibit the use of materials and equipment, recommend substitute material and equipment but they shall not authorize material and equipment substitutions.

#### 8-4 PERSONNEL EQUIPMENT.

8-4.1 Apron. An apron is used to provide protection from chemical splashes.

8-4.2 Cap. A cap or other headcover is used to protect the scalp from contact with chemicals and to prevent hair oil from contacting the aircraft. Cap material shall be at least 50 percent cotton.

8-4.3 Cotton Sweat Shirts and Pants. Sweat shirts and pants may be used as an outer garment in lieu of coveralls. Material used for sweat shirts and pants shall be at least 50 percent cotton. White or gray is the preferred color but other colors are acceptable.

8-4.4 Coveralls. The coveralls shall be static free, velcro or non-sparking button closure, closed cufflet and anklet. White is the preferred color but other colors are acceptable.

8-4.5 Gloves. Cotton and surgical gloves are used to allow free movement and to protect hands from sealant and adhesives. (Surgical gloves may require the establishment of a separate hospital supply account. Contact the local medical service logistics function for additional information.) Chemical resistant gloves are used to provide protection from fuel and solvents.

8-4.6 Knee and Elbow Pads. Knee and elbow pads are used to provide cushioning when working in tanks.

8-4.7 Shoes. Service, safety, or gym shoes are authorized in the fuel system repair area.

8-4.8 Socks. Socks shall be at least 85 percent cotton. White is the preferred color but other colors are acceptable.

8-4.9 Undershirt. Crewneck, quarter sleeve, cotton undershirts may be worn under any approved outer garment. Material shall be at least 50 percent cotton. White is the preferred color but other colors are acceptable.

8-4.10 Respirator. Respiratory protection shall be selected, used, and maintained in accordance with AFOSH 48-1. The entry authority and local BES are responsible for selecting respirators.

#### 8-5 SAFETY EQUIPMENT.

8-5.1 Air Purifier Cart. The cart is used to remove airborne contaminants, e.g., oil vapor, carbon monoxide, from shop air. The cart shall provide air conforming to specification BB-A-1034 Grade D. The cart shall be tested every 45 days. (Refer to AFOSH 48-1 and TO 42B-1-22.)

**8-5.2 Combustible Gas Alarm (Area Monitor).** The alarm is used for area monitoring. Alarm shall be preset to 20 percent LEL. The combustible gas alarm shall be used when the aircraft has been serviced with AVGAS or JP-4.

**8-5.3 Combustible Gas Indicator.** Is used to check the LEL of fuel tanks. This indicator shall be capable of accurately determining the LEL of all common aviation fuels used by the Air Force. The indicator shall be accurate for entire range of LEL for which it is used.

**8-5.4 Oxygen Analyzer.** The analyzer is used to determine oxygen content of integral tanks and fuel cells.

**8-5.5 Signs.** "DANGER - OPEN FUEL TANKS - UNAUTHORIZED PERSONNEL KEEP OUT" and "NO FUELED AIRCRAFT PERMITTED IN THIS FACILITY" may be locally produced or requisitioned in accordance with AFR 6-1, Chapter 1.

**8-5.6 Lights, Lamps and Lanterns.** With the exception of the hand held flashlights (6-volts and less); lights, lamps and lanterns shall be approved for use in a Class I, hazardous area and listed in TO 35F5-1-2. The hand held flashlight shall be approved and marked/labeled for use in a Class I, hazardous area.

**8-5.7 Streamers and Tags.** Streamers and tags shall be used to denote warnings and danger as appropriate. Red "REMOVE BEFORE FLIGHT" should be requisitioned from supply. Yellow "CAUTION - REMOVE BEFORE FUELING/DEFUELING" may be requisitioned from supply or locally manufactured (drawing is available from WR-ALC).

**8-5.8 Fire Extinguishers.** A 150 pound HALON 1211 fire extinguisher or equal (refer to TO 00-25-172) shall be in each open area.

## **8-6 LEAK DETECTING AND TRACING EQUIPMENT.**

**8-6.1 Vent Plugs, Caps and Cover Plates.** Requisition from supply or local manufacture as necessary.

**8-6.2 Water Manometer.** The manometer is used to measure the pressure in the tank (either negative or positive) and provides pressure relief should preset pressures be exceeded.

**8-6.3 Blacklight.** This light is used with fluorescent dye to detect leak paths. The blacklight shall be approved for use in a Class I, Division 1, hazardous location and meet the requirements of NEC Article 501.

**8-6.4 Leakage Tracing Device.** This box is composed of controls to which an external air pressure source is connected. The pressure source is converted to a vacuum source or dye injection source with reservoir.

**8-6.5 Vacuum Cup.** This plastic vacuum cup is provided with the leakage tracing device to confirm a sealant repair or to check under head-sealed fasteners by pulling air or dyed fuel through structure and into the plastic container.

**8-6.6 Cup, Vacuum Pressure.** This double cup assembly is a vacuum segment to hold the cup in place and a pressure segment to inject dye into the leak path.

**8-6.7 Dye Injector.** This injector is a hollow bolt used to inject dye for tracing leaks.

**8-6.8 Manometer.** Manometers are used to measure either positive or negative pressure inside fuel tanks. Both "U" shaped and vertical manometers are used. The only fluid authorized for use in the manometer is a fifty percent mixture of water and ethylene glycol. Field sized manometers are shown in figures 8-3 and 8-4. Smaller manometers are normally used for cell repair. When the water manometers is the only overpressure protection for a repair operation, the column height and, in the case of a vertical (single column) manometer, the size of the water box are important selection and sizing criteria for rapid blowout and pressure relief. Both valves should be minimal for the applicable working pressures.

**8-6.9 Plugs/Caps/Coverplates.** These are used to perform pressurization and vacuum tests. They require safety streamer.

**8-6.10 Pressure Box.** This box is used to apply pressure to a small area over the exterior leak point from which air may be forced or dye injected back along the leak path to the leak source. This may be used in the Dye Injected Methods, Blow Back Methods and Vacuum Methods.

**8-6.11 Vacuum Pump.** Instrument used to pressurize fuel tanks during leak detection processes. This pump is used in Vacuum Methods.

## **8-7 SUPPORT EQUIPMENT.**

The following items are authorized to be used in fuel system areas and may be attached to an aircraft during fuel systems repair:

**8-7.1 Air Conditioners.** Trailer mounted ground support electric, gasoline or diesel powered air conditioners can be used for fuel cell/tank maintenance when conditioned, temperature controlled air is required. This equipment is not explosion-proof and must remain outside the fuel cell repair

area. If heated conditioned air is required, the temperature applied must never exceed 150°F. The A/M32C10 air cycle conditioner (all models) can be used for this purpose. Temperature range on the air cycle air conditioner is from 48°F to 200°F.

**8-7.2 Air Mover.** The air mover operates on the venturi system. The air is supplied from a compressor to the air mover. The unit is excellent for removing vapors through vents, fillers or other small openings. (See figure 8-5.)

**8-7.3 Type MA-1 Blower.** The type MA-1 is an explosive proof non-spark producing blower and may be used inside the fuel system repair area. The blower is an excellent mass air mover used during blow or exhaust purging. Proper bonding shall be accomplished before starting the blower. The units shall be bonded to the aircraft before attaching the duct to the fuel cell/tank opening. The MA-1 blower duct shall be obtained from stock and inspected to assure that the reinforcement coil is bonded to the outlet ring. In the event it is not, the ducts shall be modified to complete this bond prior to use. The filter for the MA-1 blower is designed to prevent the blower from picking up sand, dust and dirt and blowing into the cell/tank. The filter is a locally manufactured item. The drawing shall be obtained through WR-ALC/TIL, Robins AFB, GA 31098-5609. Filters in the assembly should be cleaned and replaced as required. Blower equipped with a filter may be used to supply air into cell/tank for personnel comfort when accomplishing repair.

**8-7.4 Fuel Cell/Tank Servicing Cart.** This cart is used as a central point for breathing air supply bottles, regulators and respirator hose. It is to be used to store material, personnel equipment and provides outlets for respirators. The cart is to be bonded. Each time a tank entry is made using cylinder breathing air from cart, a standby person shall be at the cart.

**8-7.5 Nitrogen Cart.** There are two approved carts that can be used in supplying nitrogen to fuel system when inerting is required. Carts shall be marked as stated in TO 35-1-3 and TO 42B5-1-2.

**8-7.6 Vacuum Cleaner.** This cleaner is an explosion-proof air-operated cleaner. The cleaner may be used to remove any fuel from cell/tank that will not drain from sumps, drains or other normal drain procedures. The cleaner shall be bonded to the aircraft prior to starting.

**8-7.7 Air Compressor.** A portable cart mounted air compressor which can be used for fuel cell/tank maintenance when a compressed air source is

required. Non-explosion proof air compressors are kept outside the fuel system repair area. When used as an air supply to personnel entering fuel cell/tank, it is connected directly to the air purifier cart which removes air contaminants. Explosion proof compressors are in the MB-1 series.

**8-7.8 Container.** Approved safety containers used in draining fuel from aircraft can be obtained in sizes from two quarts to 1000 gallons. Locally manufactured or procured containers shall meet the requirements of AFOSH 127-43 and TO 00-25-172.

**8-7.9 12-Inch duct for Dock Installed Purge Equipment.** The ducts received from stock must be modified to insure that the reinforcement coil is bonded to the end ring prior to use.

**8-7.10 Heaters.** These are portable heaters used to supply heated air to a work area, fuel cells/tanks when purging, and curing sealants and coatings. The following are approved heaters:

**8-7.11 Type H-1 heaters** are not explosion proof, but have combustion chambers that are sealed from the ventilating chambers. These heaters can be connected through a plenum chamber to the fuel cell/tank opening using the ducts supplied with the unit.

**8-7.12 HDU/13.** The HDU/13 is an explosion proof heater that may be operated inside the fuel system repair area, hangar or nose docks. These heaters can be connected directly to the fuel cells/tank opening through the ducts supplied with units. Temperatures may be controlled on the heater by manual control as desired from 40° F to 200° F. Any selected temperatures above a maximum ambient will be automatically maintained regardless of air flow or ambient temperature changes within the 100,000 BTU/Hour capacity of the heater. This heater can be used to purge aircraft fuel cells/tanks (blow/exhaust purge method) and to cure sealant and coatings.

**8-7.13 Plenum Chamber.** The plenum chamber is a locally manufactured item which is used to reduce the air temperature from a heater by mixing with ambient air.

**8-7.14 Ambient Air Breathing Pump.** This portable, oil-less, pump is used to deliver low pressure ambient air for up to three people at a time.

**8-7.15 Pneumatic Powered Fan.** This 12-inch fan can be used for either blow or exhaust purge of aircraft fuel.

**8-7.16 Eight-Inch Pneumatic Powered Blower.** This blower may be used to blow purge aircraft fuel tanks during fuel systems maintenance.

8-7.17 Rubber Buckets. Approved buckets may be used to drain small amounts of fuel from aircraft. These containers are 3 gallon capacity and are non-conductive so they need no bonding.

8-7.18 SCEON Light. The explosion proof SCEON light is used in conjunction with a variety of light diffusing attachments and cables provides light for tank and cell interiors. SCEON light kits may be individually assembled based on local requirements. The model GSLX4000 has four NSNs. The difference is the length of the power cable, generally a 100-foot cable will be sufficient.

#### 8-8 REPAIR EQUIPMENT.

The following items are authorized for use during fuel system repair:

8-8.1 Buffing Band. These bands are for buffing arbors and are provided in various grits.

8-8.2 Fuel Cell Buffers. These buffers are used for heavy buffing such as removing fitting flanges, buffing self sealing cells, buffing light weight cells and finishing work on beads, etc.

8-8.3 Buffing Stone. These grindstones are used in buffing bladder cells and fitting flanges.

8-8.4 Electric Knife. This knife shall be equipped with a tungsten carbide cutting edge used for carving foam material (polyurethane).

8-8.5 Hot Knife Blade. A locally manufactured item used in fuel cells to remove fittings and trim sealants. (Ref. USAF drawing 61B25215.)

8-8.6 Sealant Spatula. Sealant Spatulas are stocklisted in sets of three.

8-8.7 Stitcher Horizontal Offset. This stitcher is used in patch repair of fuel cells. The offset provides a means of stitching patches in corners. The small wheel provides the repairman close contact with stepoff areas. (see figure 8-8.)

8-8.8 Roller Stitcher. This stitcher is used to apply patches in thin type cell or other areas in which a short stitcher is desired. (see figure 8-9.)

8-8.9 Stitcher Vertical Offset. This stitcher is used to accomplish patch installation in confined areas. (see figure 8-10.)

8-8.10 Temporary Repair Kits. Comp Air D-236 Injector Kit.

#### 8-9 SEALING EQUIPMENT.

The following items are authorized for use when sealing fuel systems and are divided into two categories. Curing type sealing equipment, and non-curing type sealing equipment.

8-9.1 Sealant Scraper. This scraper is used to remove damaged sealant. The scraper is a non-spark producing cutting tool. Acceptable materials are plastic, wood, phenolic, or aluminum. (see figure 8-7.)

8-9.2 Shot Bag. A locally manufactured bag filled with shot which is used in fuel system repair to anchor items such as air mover, air hose, etc.

8-9.3 Curing Type Sealing Equipment.

8-9.4 Cartridges, sealant containers. There are seven sizes of cartridges stocklisted for Air Force use. The cartridges are stocklisted with and without plungers. (see figure 8-11.)

8-9.5 Kit Gun and Mixer. The kit contains a filleting and injection gun, mixer for cartridges, service wrench for filleting, 2-1/2 ounce retainer, six ounce retainer for the filleting gun, flexible hose for filleting gun, brush cap cleaner for injection gun, rod cleaner for each size nozzle and two high pressure hose extensions for the injection gun.

8-9.6 Sealant Mixer. Semkit Model 285 is approved for mixing sealant used in integral fuel tanks. This machine provides a method to economically and efficiently mix cartridges. It greatly reduces the mixing time while assuring thorough mixing. The machine provides the operator a tool to maintain consistency in mixing.

8-9.7 Filleting Nozzles. Nozzles for filleting are available through Air Force stock in various size, shapes and orifice sizes. Standard nozzles may be cut to any angle required in applying fillet. The thickness of fillet is controlled by the orifice size. (see figure 8-12.)

8-9.8 Injection Nozzles. Nozzles for injection guns are available through Air Force stock in three sizes. They are 3/16, 1/8, 3/32-inch orifice.

8-9.9 Cartridge Sealant Plunger. There are two types of plungers available through Air Force stock. The 250P plunger can be used in the cartridge for filleting gun only. The 250 plunger is equipped with a removable plug that can be used with either the filleting or the injection gun.

8-9.10 Filleting Guns Retainer. The retainers are stocklisted in two sizes, 3-1/2 oz. and 6 oz. The retainer is selected for the size of cartridge to be used.

8-9.11 Cleaner for Nozzles Injection Gun Rods. The rods are stocked in the same size as the orifice for the nozzles. The cleaners are to remove clogged sealant in nozzles.

8-9.12 Sealant Gun. There are several curing type sealant guns used to apply fillet seals, adhesives and resins.

(Semco 750)  
(Semco 850)  
(Model 250-6)

8-9.13 The following are approved curing type sealant guns:



8-9.14 Non-Curing Sealing Equipment. The following is a list of approved non-curing type sealant guns:

Model 223  
Model 225  
Model 227  
Model 507A  
Model 509

## 8-10 MATERIALS.

The approved materials for use in fuel system repair are divided into the following categories: sealants, adhesives, cleaners/solvents, external (temporary) patch materials, fuel cell repair materials, corrosion protection materials, leak detection materials, purge fluids, fire suppressant foam, paints, and general materials. All materials listed may not be necessary to perform fuel tank repair. Consult the system peculiar technical manual or this technical manual for requirements.

### NOTE

Some adhesives, sealants and cements require special storage. Refer to the stocklist, AFM 67-1, VOL 7, PART 3, or manufacturer's recommendations. Attention must be paid to the shelf life and age control examination.

8-10.1 SEALANTS. The following types of sealants are primarily used to seal integral fuel tanks and are divided into three classifications - curing sealants, non-curing sealants and structural adhesive sealants:

#### 8-10.1.1 Curing, Fuel Tank Sealants.

- a. MIL-S-29574 Low Temperature Curing (PR-1826)
- b. MIL-S-8802 for Jet Fuel Tanks
- c. MIL-S-83430 High Temperature Performance
- d. MIL-S-81733 Corrosion Inhibited
- e. MIL-S-83318 Low Temperature Curing
- f. MIL-S-8784 Low Adhesion
- g. PRO-Seal 872 High Adhesion Access Door Sealant
- h. PR 1403 Corrosion Inhibiting Low Adhesion Access Door Sealant
- i. PR 1828 Low Temperature Curing

#### 8-10.1.2 Non-Curing, Injection Sealants.

- a. PR-702 Non-curing Rubber Based Sealant

- b. Q-94-011 Non-curing Fluorosilicone Sealant
- c. Q-94-031 Non-curing Fluorosilicone Sealant
- d. G-651 Non-curing Cyanosilicone Sealant
- e. Q4-2805 Non-curing Fluorosilicone Sealant

#### 8-10.1.3 Structural Adhesive Sealant.

- a. AF-10 Thermosetting, nitrile phenolic

8-10.1.4 General features of these sealants are as follows:

- a. MIL-S-8802 is a fuel resistant sealant. Most aircraft are sealed with this material. The sealant is cured by the addition of an accelerator to the base compound in accordance with the manufacturer's instructions. Class A material is for brush application, Class B for filleting, and Class C for faying surfaces. It is also available with varying application lives, such as 1/2 hour and two hours. A topcoat is not usually used, however, a polyurethane coating (MIL-C-83019) is recommended when uncoated cadmium is present.
- b. MIL-S-83430 is similar to MIL-S-8802 except it has better high temperature performance, designed for limited service life at temperatures up to 360°F. MIL-S-83430 may be used as a substitute for MIL-S-8802 to make repairs but the reverse is not true without system manager approval.
- c. MIL-S-81733 is similar to MIL-S-8802 with added chromates for corrosion inhibition. It is used in faying surfaces and for installation of fasteners.
- d. MIL-S-83318 is two-part temperature (20° F minimum) curing sealant for repair of aircraft integral fuel tanks and fuel cell cavities in a cold environment. The sealing compound is a Class A consistency, suitable for brush or extrusion gun application. It cures to a fuel resistant rubber at temperatures from 20° F, upward. A primer is furnished with the material.
- e. MIL-S-8784 is a two-part, low adhesion sealant for use on some faying surfaces, and gasket type seals for access doors and accessories. The sealant is colored red to distinguish it from MIL-S-8802 material. MIL-S-8784 is available in two dash numbers indicating - 1/2 and -2 hours work-life. The sealant is also supplied in two viscosities, Class A (suitable for brush application) and Class B (suitable for application by spatula or filleting gun).

- f. Pro-Seal 872 is a two part, high adhesion fuel resistant, electrically conductive, corrosion inhibitive sealing compound for access doors.
- g. PR-1826, Class A or B is a two part chemically curing polythioether polymer based sealant characterized by rapid cure at low temperature to a fuel resistant elastomer. This material has application temperatures as low as 40°F. When used with PR-1826 primer, the sealant adheres to Alclad, MIL-A-8625, MIL-C-5541, Titanium, Stainless Steel MIL-C-27725, coated surfaces and MIL-C-8802 sealants. PR-1826 Primer will promote adhesion of PR-1826, Class B to itself and to materials and treatments commonly used for aircraft fasteners.
- h. PR702 is a non-curing one part synthetic rubber based sealant which does not harden and remains flexible. It is "semi-fluid" which allows "old" sealant to be flushed from sealant grooves/channels during leak repair efforts. It is common to the A-7 aircraft.
- i. Q-94-011 and Q-94-031 are non-curing one-part fluorosilicone based sealants which do not harden and remain flexible. Q-94-031 is the same as Q-94-011 but contains plastic beads which pile up at leakage points and tends to be better for sealing leaks. Color is white or light gray and is a "semi-fluid" material.
- j. G-651 is a non-curing one-part cyanosilicone based sealant. It contains beads like Q94-031. The color is yellow.
- k. Structural adhesive AF-10 is a thermo-setting adhesive which requires an approved oven to cure the material. The adhesive is used for faying surface sealing in some integral tank designs. If damaged in service, it is repaired by fillet overcoat of MIL-S-8802 or MIL-S-83430.

8-10.2 ADHESIVES/CEMENTS. The following are adhesives/cements approved for use as stated in applicable sections of this technical manual:

- a. Adhesive, for Fuel Cells, MIL-A-9117
- b. Adhesive, Heat Vulcanizing.
- c. Adhesive, MIL-A-46050
- d. Cement, Hot or Cold Bonding, MIL-S-13883
- e. Cement, MMM-A-122
- f. Cement, two part 5923C

- g. Adhesion Promoter, PR-148

8-10.3 CLEANERS/SOLVENTS. The following is a list of approved cleaners and solvents for fuel system repair. Refer to integral tank or fuel cell section for detailed use.

- a. Acetone
- b. Alcohol, Ethyl, MIL-A-6091
- c. Alcohol, Isopropyl, TT-I-735
- d. Cleaner Compound, MIL-C-87937
- e. Cleaning Solvent, MIL-C-38736
- f. Ethyl-Acetate, TT-B-751
- g. Methyl Ethyl Ketone (MEK), TT-M-261
- h. Methyl Isobutyl Ketone (MIBK), TT-M-268
- i. Toluene, TT-T-545
- j. Desealant Type I, Class B, MIL-D-9063
- k. Naphta, TT-N-95

8-10.4 EXTERNAL (TEMPORARY) PATCH MATERIAL. The following is a list of approved patch materials for making temporary repairs. See applicable section of text for proper repair procedure and material use.

- a. Hardman Fast Setting Adhesive
- b. Epoxy Tabs Type O
- c. Aluminum Foil 0.0015, 0.0020 inch
- d. Aluminum Stock 2020ST, Aluminum Stock 5052
- e. Pressure Sensitive Aluminum Tape
- f. Loctite Sealant, Grade A, MIL-S-22473
- g. Oyltite Stik
- h. Cellophane, Clear 6-inch Wide

8-10.5 FUEL CELL REPAIR MATERIAL. The following is a list of approved patch material for fuel cells: (For proper use and applications refer to section on fuel cell repair):

- a. BUNA-N (Nitrile) Sandwich Material
- b. A-Nylon Nitrile Sandwich Material
- c. Cloth, Laminated 2 Ply, Nylon
- d. Epoxy Patching Compound
- e. Fabric, Sheet Nylon Sandwich
- f. Nylon, Liquid Blue, Goodyear 5073C
- g. Nylon, Liquid Yellow, Goodyear 5074C
- h. Sheet, BUNA-N (Nitrile) 0.035 inch

- i. Sheet, Sealant Gum (Self-Sealing Cell)
- j. Sheet, Sq, Cloth Coated 0.020 inch thick

8-10.6 CORROSION PROTECTION. Approved materials for corrosion protection are as follows: (Refer to proper section for application and uses):

- a. Conversion Coating, MIL-C-81706
- b. Coating, Corrosion Protection, MIL-S-4383 (BUNA-N)

8-10.7 LEAK DETECTION MATERIAL.

- a. Ammonium Hydroxide, O-A-491
- b. Bulb, replacement type, Black Light
- c. Deleted
- d. Dye, Liquid, Yellow
- e. Phenolphthalein
- f. Powder, Dyed Red Talcum
- g. Soap, Bubble Solution non-corrosive, MIL-L-25567
- h. Soap Suds Test
- i. Zyglo ZL-22
- j. Widger WC-4700

8-10.8 PURGE FLUIDS. Approved purge fluids are as follows:

- a. Purge Fluid per specification MIL-F-38299
- b. JP-8 Fuel,
- c. JP-5 Fuel, MIL-T-5624

8-10.9 FIRE SUPPRESSANT FOAM.

8-10.9.1 Black felt tip marker for identifying replacement foam baffles. Blaisdell liquid tip No. 1173-F, Blaisdell Pencil Co., Bathayres, PA, or equivalent.

8-10.9.2 Foam buns, MIL-B-83054, standard bun sizes include:

- a. Yellow Type II and Dark Blue Type IV
  - (1) 40 x 80 x 8 inch bun
  - (2) 44 x 110 x 12 inch bun
  - (3) 44 x 110 x 8 inch bun
- b. Red Type III and Light Blue Type V
  - (1) 44 x 110 x 8 inch bun
  - (2) 44 x 110 x 12 inch bun

8-10.9.3 Foam buns, MIL-F-87260, standard bun sizes include eight and 12 inch widths

8-10.10 COATINGS. The following is a list of approved coatings: (Refer to proper section for correct use):

- a. Paint, Buna Vinylite Lacquer
- b. Paint (White for Stencilling), TT-C-50
- c. Coating, Polyurethane, MIL-C-83019
- d. Primer, Metal
- e. TY-PLY "N" Primer
- f. Buna-N (Nitrile) Integral Tank Coating MIL-S-4383

8-10.11 GENERAL MATERIALS. The following is a list of approved materials used in various fuel system repairs: (Refer to proper section for correct use):

- a. Brush, Acid, Swabbing, H-D-643
- b. Brush, Aluminum
- c. Brush, H-B-451
- d. Brush, Camel Hair
- e. Brush, Ox Ear Hair
- f. Brush, Stiff Bristles, H-B-328
- g. Brush, Squirrel Tail Hair
- h. Brush, Varnish, H-B-695
- i. Cheesecloth, Bleach, MIL-C-87962, Type I
- j. Cleaner Soap (Floor Dock)
- k. Cloth, Cotton Bunting (Wiping), CCC-C-439
- l. Cloth, Emery
- m. Cloth, Holland, White, 1 inch wide, MIL-C-17564
- n. Cloth, Laminated
- o. Cord, Nylon Type III, 500 yd., MIL-C-5040
- p. Crayon Marking Yellow
- q. Cream, Hand Cleaner Type I, P-H-31
- r. Cup, Paper, UU-C-834
- s. Detergent, 1 gal, MIL-D-16791
- t. Ethylene Glycol, MIL-E-9500
- u. Gauze Pads, MIL-C-87962, Type II
- v. Glycerine USP, MIL-O-491
- w. Kaydry Towels
- x. Lubricating Oil, VV-L-825
- y. Paper, Kraft, UU-P-268

T.O. 1-1-3

- z. Petrolatum Type A, Class 2, VV-P-236
- aa. Plastic Bags and film, MIL-B-81705
- ab. Protective Skin Cream
- ac. Skin Protective Compound, PS-411, Type I
- ad. Soap (for Cell Cleaning) commercial, liquid, non-abrasive dish or laundry soap/detergent
- ae. Sponge, Cellulose, L-S-00626
- af. Steel, Round Rod
- ag. Tape, Waterproof, 1 inch wide, PPP-T-60
- ah. Tape, Masking 2 inches wide, PPP-T-42
- ai. Tongue Depressor
- aj. Type I Cord Assembly
- ak. Water, Distilled, O-B-41
- al. Zinc Chromate Putty, MIL-P-8116
- am. Cellulose Sponge

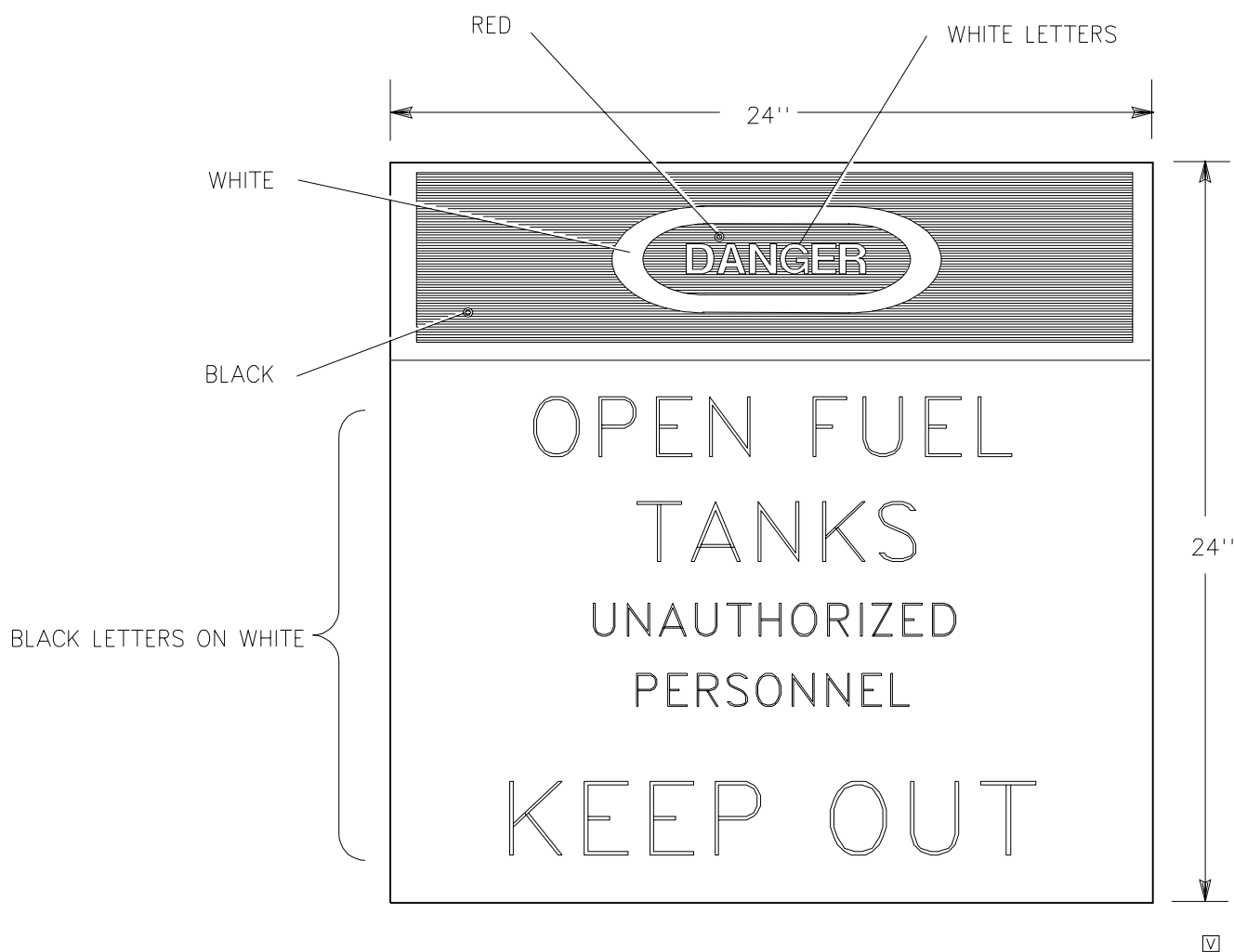


Figure 8-1. Marking of Fuel System Repair Area

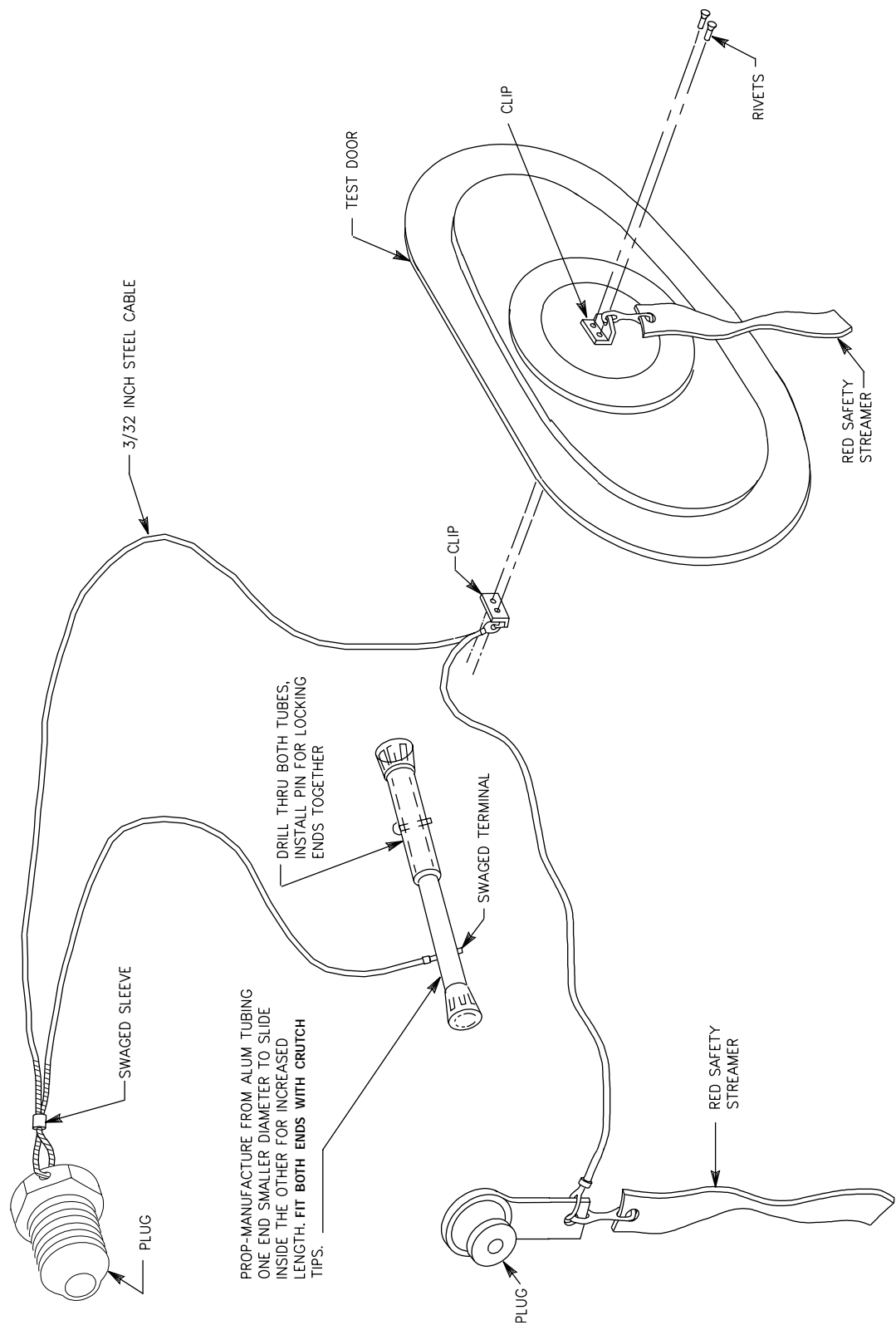


Figure 8-2. Safety Streamers for Test/Support Equipment

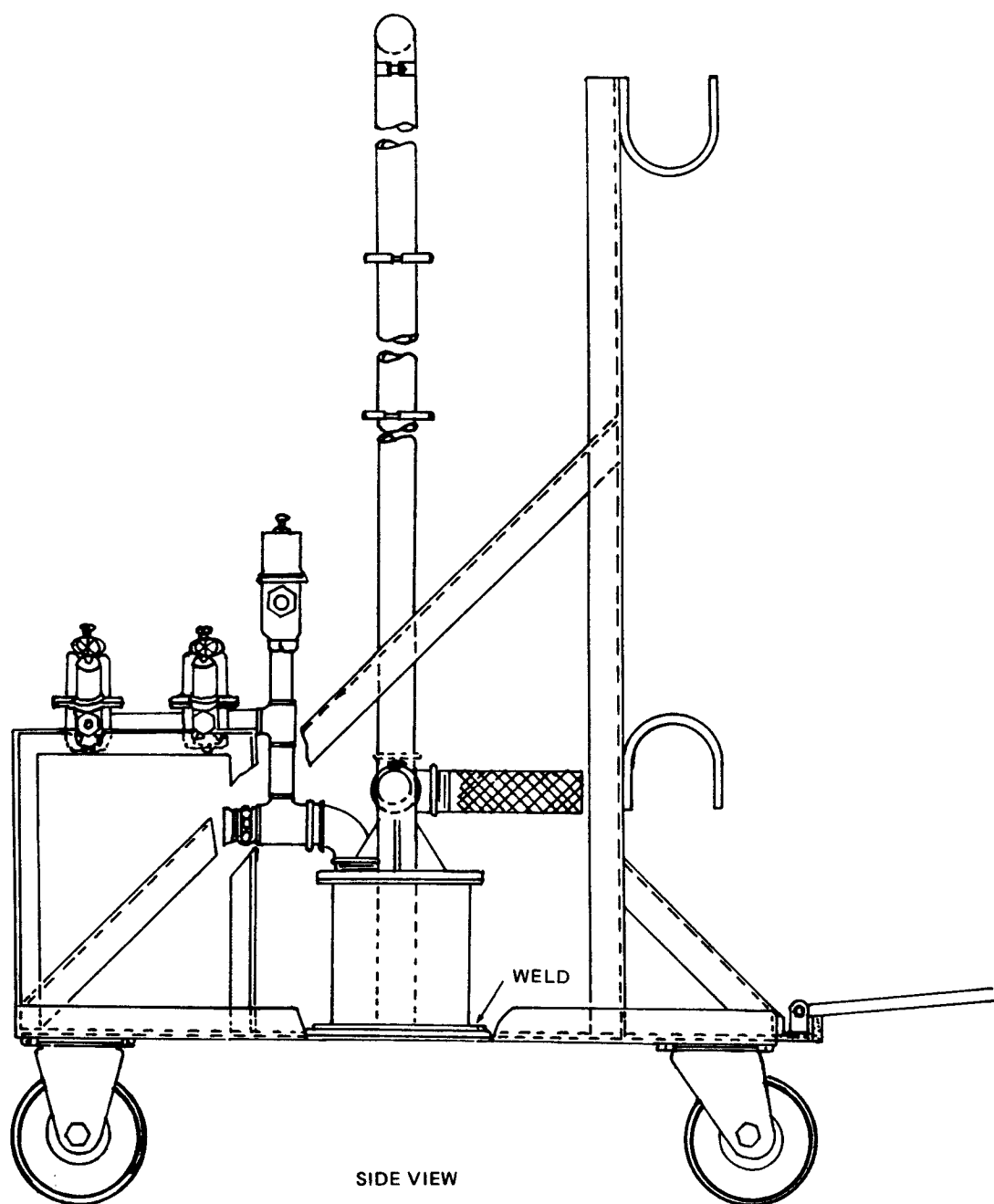
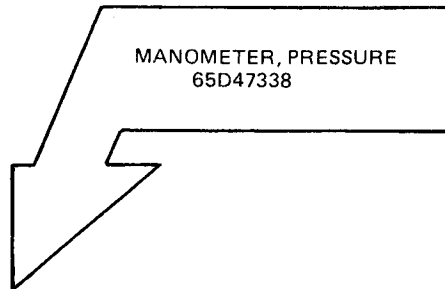

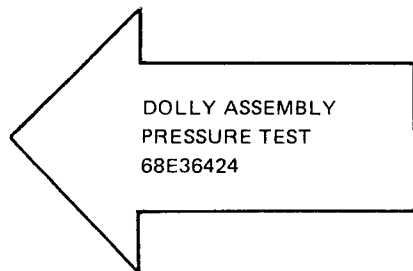


Figure 8-3. Manometer, Water 68E36424 (Sheet 1 of 2)



QTY REQD	NOMENCLATURE	MFG. CODE	IDENTIFICATION NUMBER
1	RESERVOIR	98752	65C47335
1	GASKET	98752	65B47328
1	TOP PLATE	98752	65C47336
1	SUPPORT ASSY.	98752	65B47327
1	STAND PIPE	98752	65C47337
1	PIPE EXTENSION	98752	65B47326
6	GUSSET	98752	65B47325
4	BRACKET	98752	65B47334
1	PLUG	98752	65B47323
1	WASHER	98752	65B47324
4	BOLT		AN3-44
10	BOLT		AN10-15
6	NUT		AN315-3
2	CLAMP		AN755-38
2	SCREW		AN520-10-8
10	NUT		AN325-10
10	WASHER		AN935-1016
2	ELBOW	14959	2" STD, 90" SCREWED COML B.I.P.
1	TEE	14959	2X1X2 COML B.I.P.
3	NIPPLE	14959	2" STD CLOSE COML B.I.P.
1	ADAPTER	94559	M6189 COML 2" DIA. N1 1/8 WALL
1	DAIRY TUBE		COML  PLASTIC TUBE



QTY REQD	NOMENCLATURE	MFG. CODE	IDENTIFICATION NUMBER
1	PRESSURE MANOMETER	98752	65D47338
2	CASTER		MS24380-8RU
2	CASTER		MS24380-8SU
2	VALVE	14959	1610 1/2 "Y" PATTERN DIAPHRAGM
1	VALVE	14959	2551 1" POP SAFETY VALVE SET AT 4 PSI RANGE 0 TO 30 PSI
	REGULATOR	43990	20AJ-X4GG DISCHARGE PRESSURE SET AT 3 PSI RANGE 0 TO 30 PSI
	REGULATOR	43990	20AJ-X4GG DISCHARGE PRESSURE SET AT 3.5 PSI
1	SOCKET	93064	DC-060
1	TEE	14959	1X1X1 BLACK IRON
1	TEE	14959	1X1/2X1/2
3	NIPPLE	14959	1 STD
5	NIPPLE	14959	1/2 STD
1	ELBOW	14959	1/2-90° STD
1	FRAME		67-SKA-E-142
1	TONGUE	98752	X64D45550
6	CLIP	98752	X64B45551
16	BOLT		AN8-13
3	BOLT		AN6-21
16	NUT		AN325-8
3	NUT		AN345-16
16	WASHER		AN935-816
3	WASHER		AN935-616
2	U-BOLT		SEE DETAIL
4	NUT		MS51967-2
4	WASHER		AN935-416

Figure 8-3. Manometer, Water 68E36424 (Sheet 2 of 2)

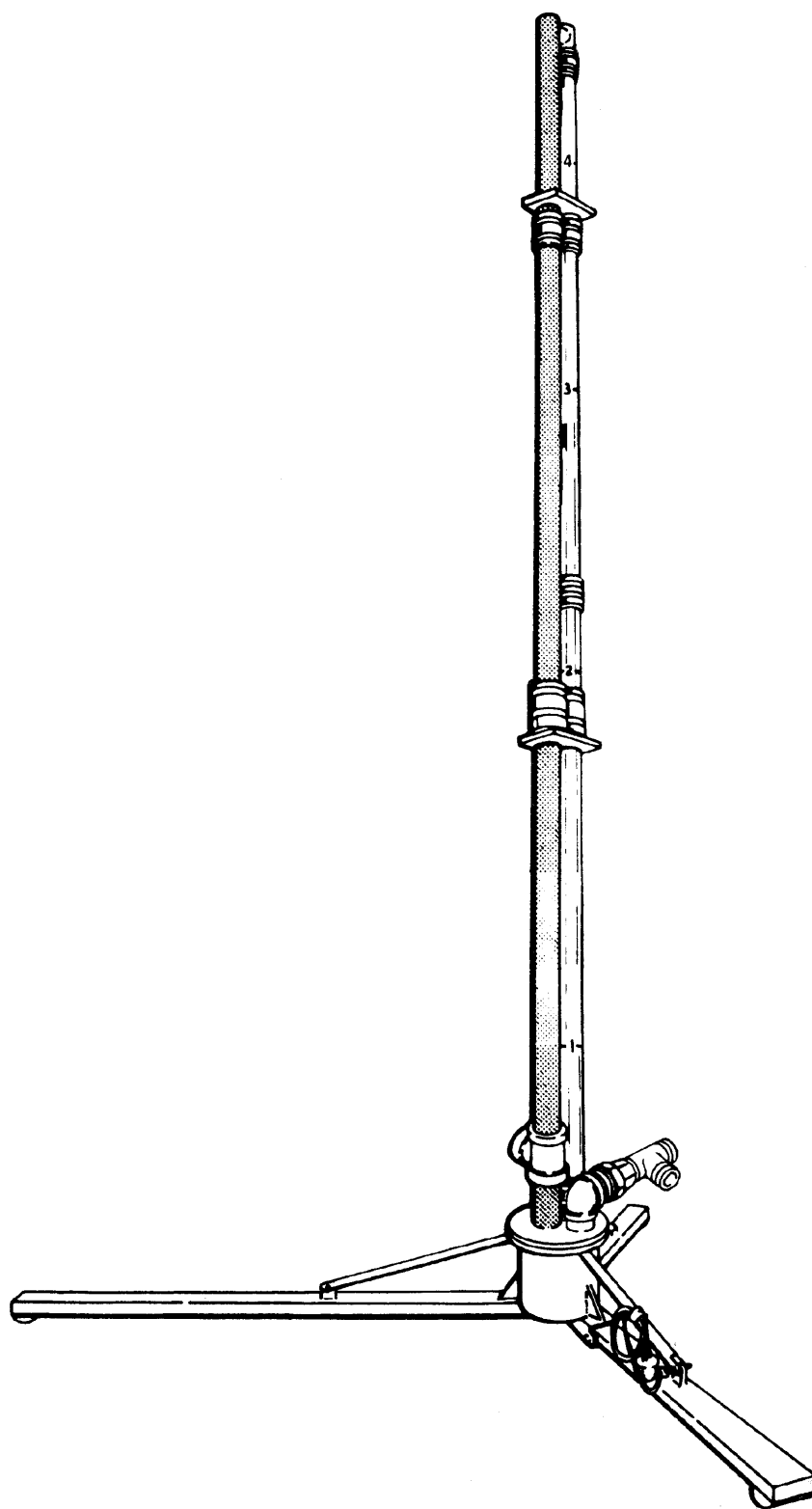
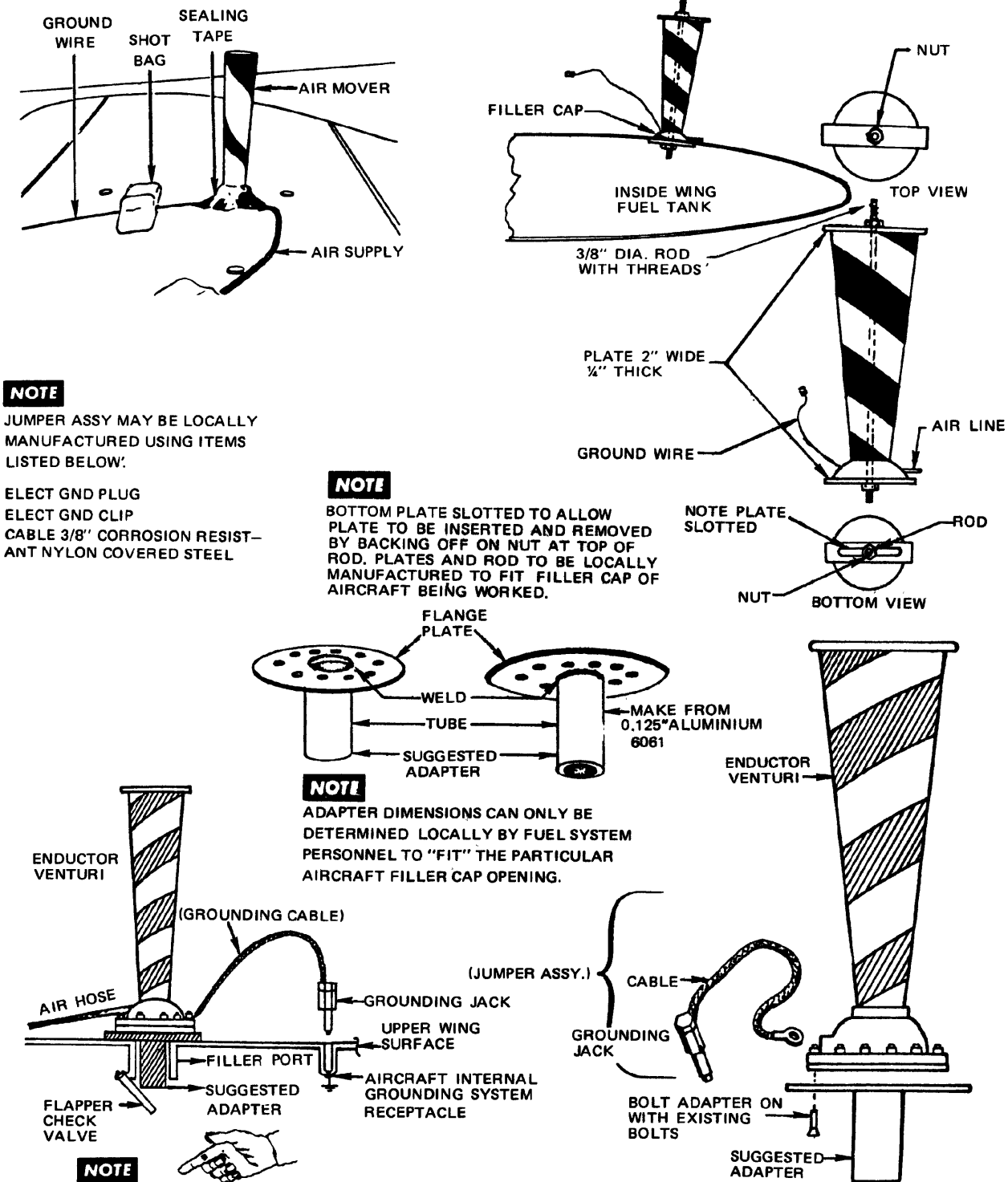


Figure 8-4. Manometer, Water F52828-116



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Figure 8-5. Air Mover

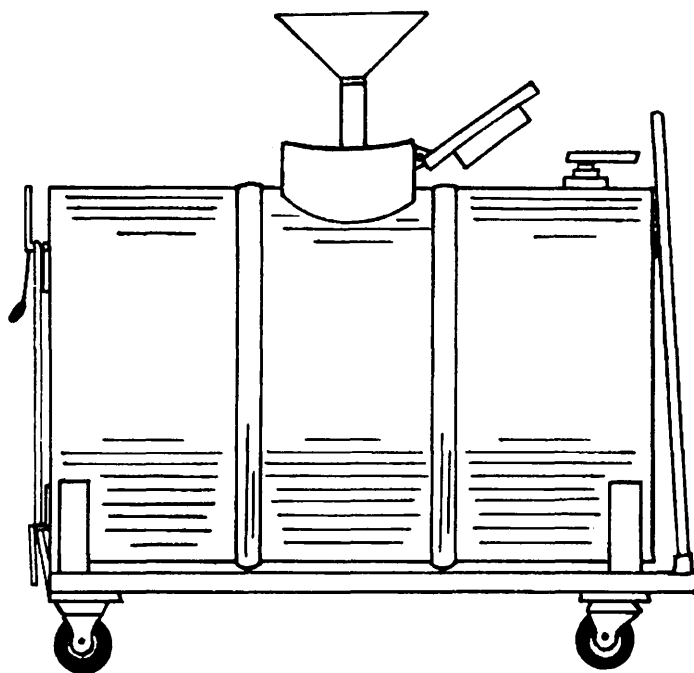


Figure 8-6. Container Drum Horizontal

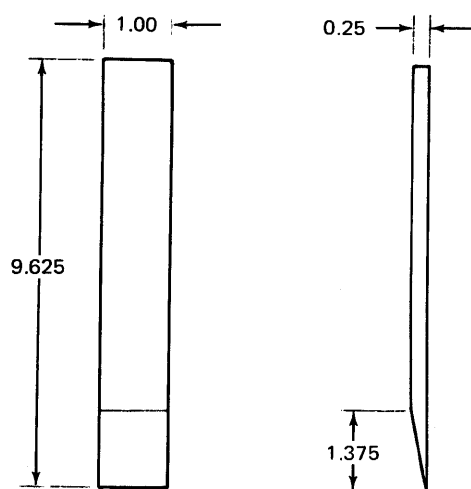


Figure 8-7. Typical Hand Scraper

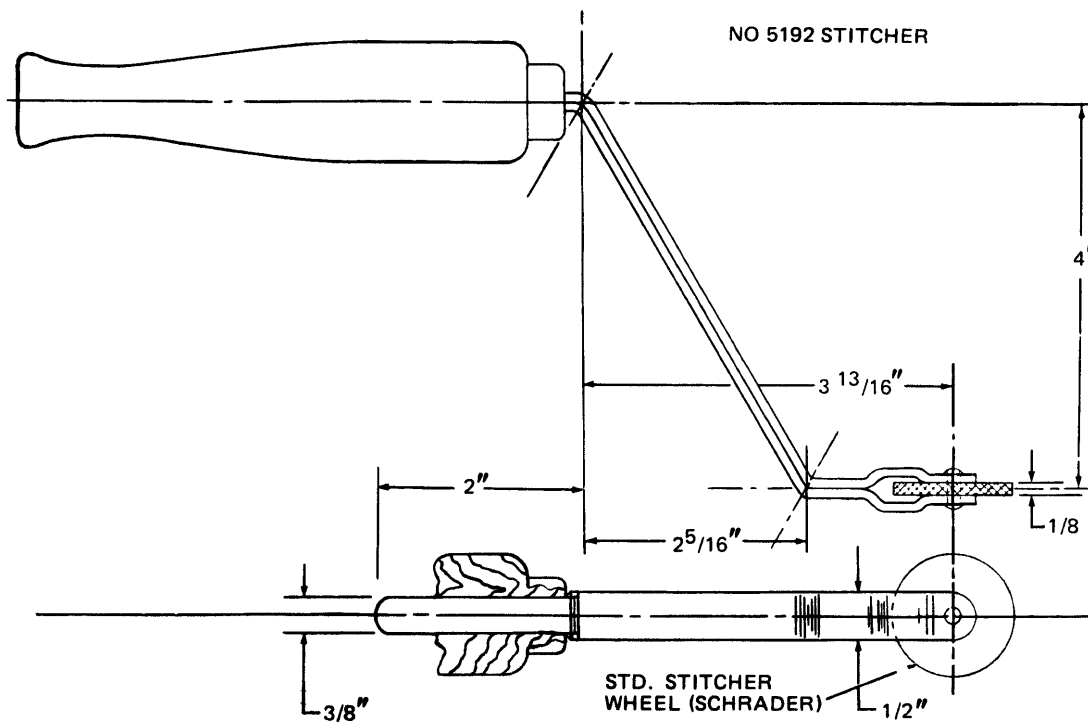


Figure 8-8. Stitcher Horizontal Offset

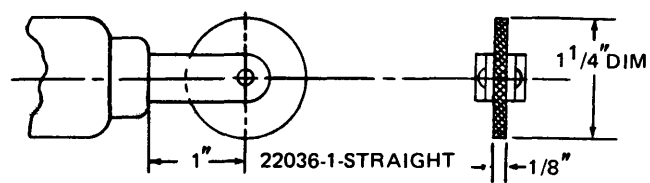


Figure 8-9. Stitcher Roller

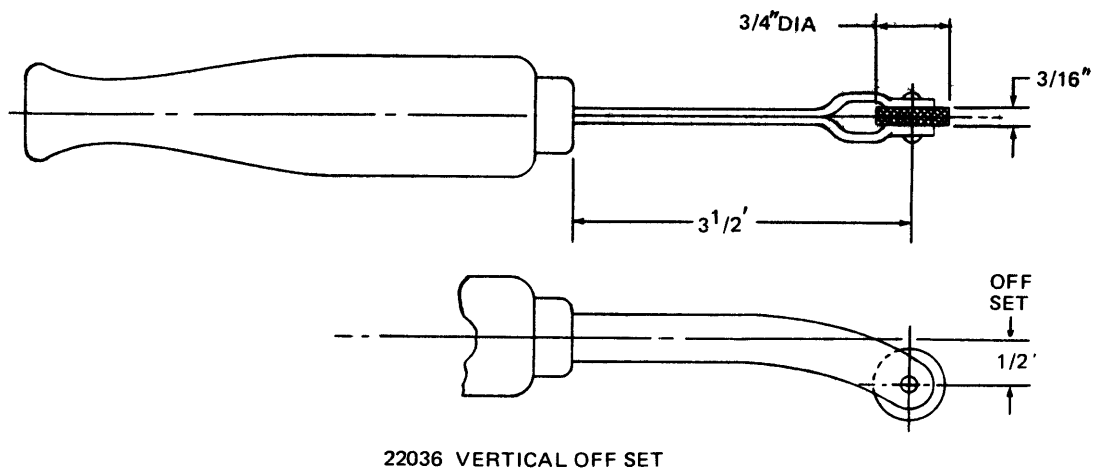


Figure 8-10. Stitcher Vertical Offset

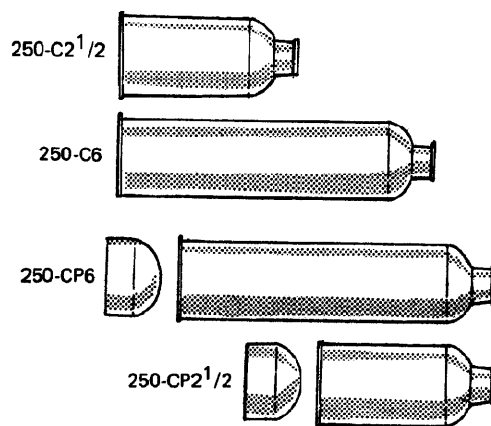


Figure 8-11. Cartridges Sealant

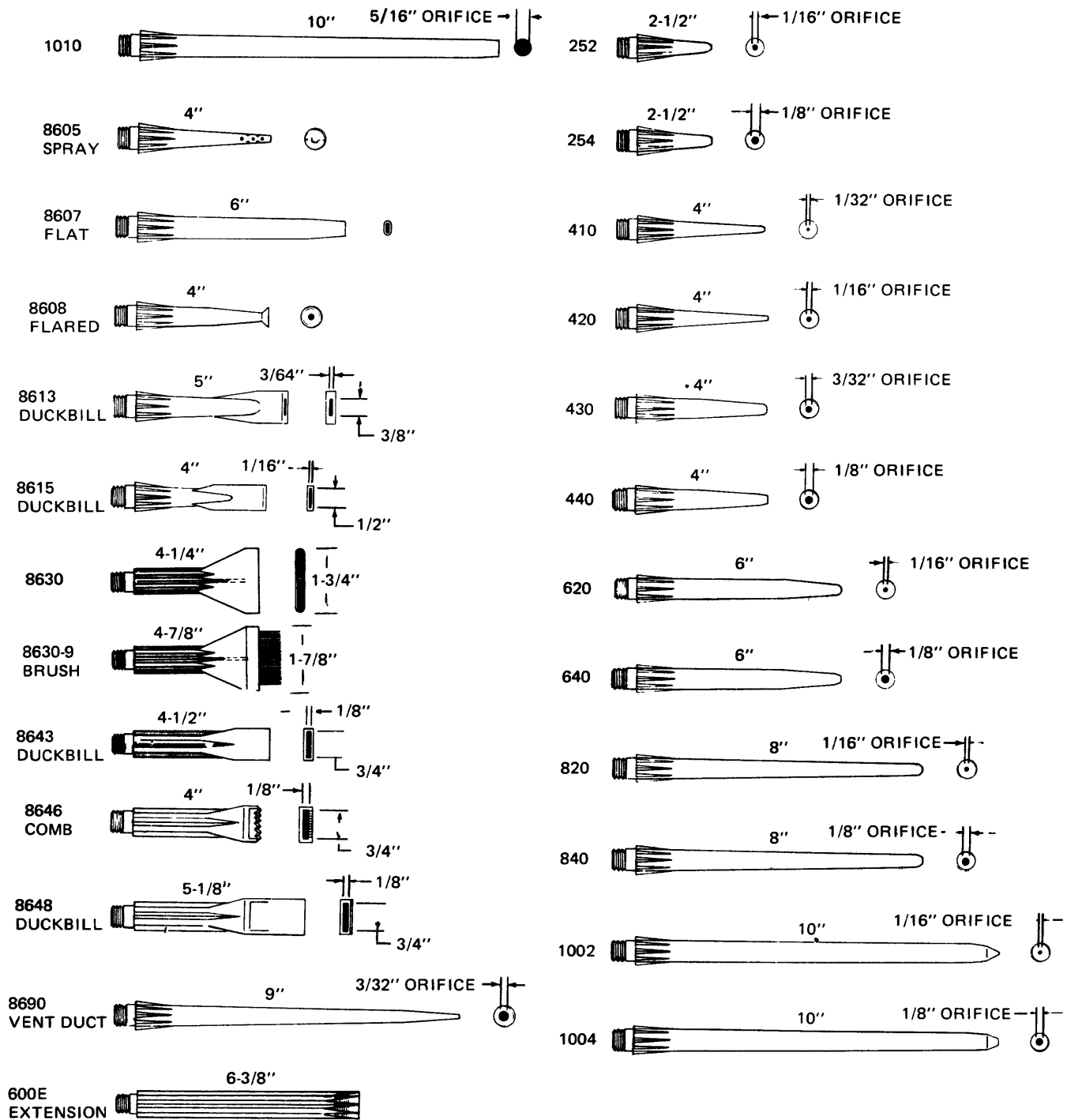


Figure 8-12. Nozzle Filleting

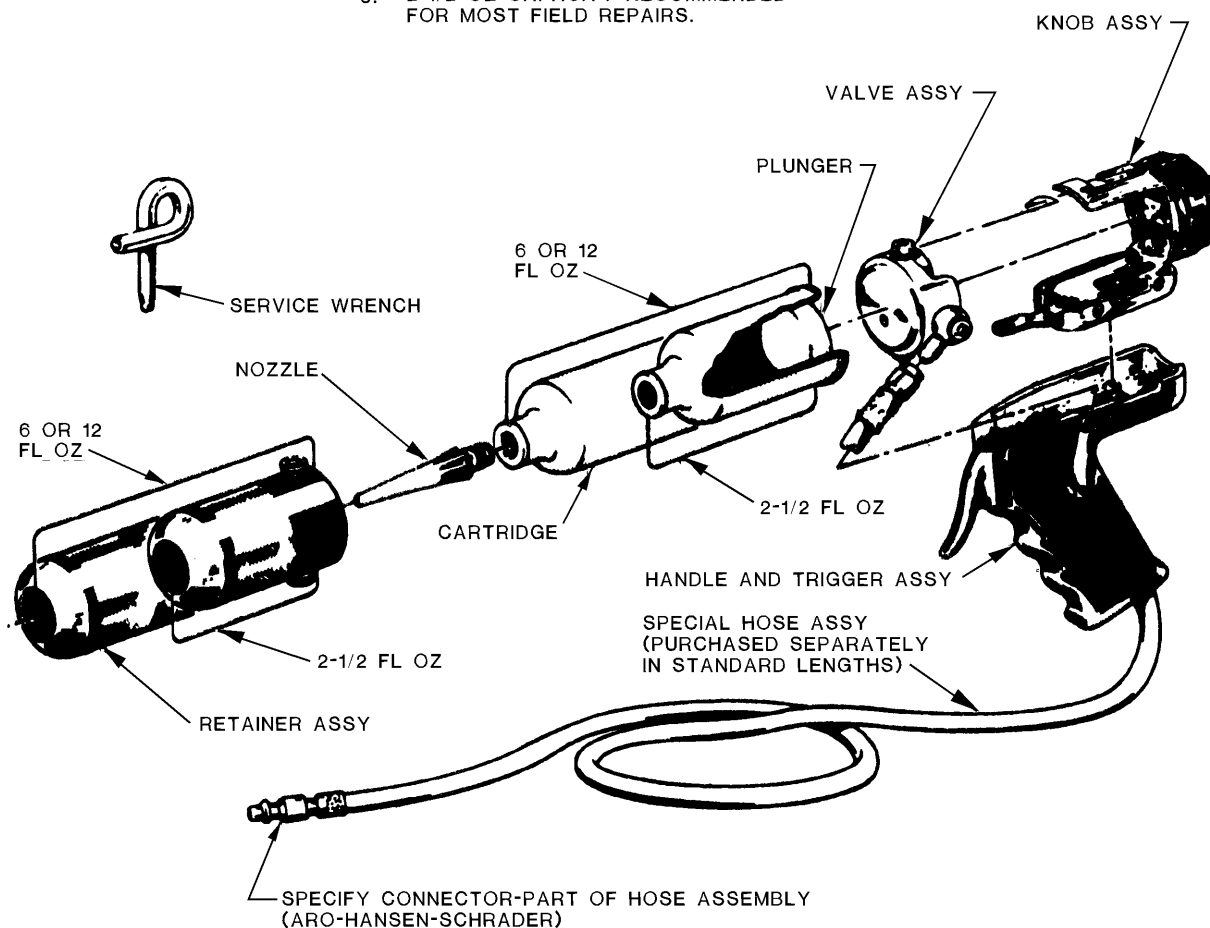
## 3 GUN MODELS

*50-2-1/2 . . . . .	2-1/2 OZ CAPACITY
250-6 . . . . .	6 OZ CAPACITY
250-12 . . . . .	12 OZ CAPACITY

ALL PARTS INTERCHANGEABLE

**NOTE**

1. PLASTIC CARTRIDGE AND STEEL SAFETY RETAINER DETERMINES CAPACITY. ALL OTHER PARTS ARE IDENTICAL.
2. TOTAL WEIGHT (6 FL OZ GUN) -15 OZ.
3. LENGTH OVERALL LESS NOZZLE (6 OZ GUN) -8-1/2.
4. PISTOL GRIP HANDLE MAY BE REMOVED TO CONVERT TO LEVER THROTTLE FOR CONFINED AREAS.
- \*5. 2-1/2 OZ CAPACITY RECOMMENDED FOR MOST FIELD REPAIRS.



L9401636

Figure 8-13. Filleting Gun

Table 8-1. Materials and Equipment

ACETONE	0-A-51	6810-00-223-2739 - - - - - - - - -	PT	GENERAL PURPOSE SOLVENT	S9G	
ADHESION PROMOTER, CHLORIMATED	PR-147	8030-01-093-5383 - - - - - - - - -	PT	INCREASE ADHESION OF SEALANTS	GSA	
ADHESIVE PROMOTER, AEROSOL	PRO SEAL 152 PRO SEAL 151	8030-01-132-0235 8030-01-131-3228 - - - - - - - - -	CN CN	INCREASE ADHESION OF SEALANTS	GSA GSA	16 OUNCES 16 OUNCES
ADHESIVE PROMOTER, NON-CHLORINATED	PR-148	8030-00-560-8755 - - - - - - - - -	PT	INCREASE ADHESION OF SEALANTS	GSA	
ADHESIVE, HEAT VULCANIZING	1895C LP729	8040-01-280-5524 8040-00-200-6415 - - - - - - - - -	KT KT	CELL REPAIR	GSA GSA	PINT QUART
ADHESIVE, HOT OR COLD BONDING	MMM-A189, CLASS 2	8040-00-543-7171 - - - - - - - - - - - -	PT	NITRILE CELL REPAIR	GSA	

Table 8-1. Materials and Equipment - Continued

ADHESIVE, PHOECCEL	5071C	8040-00-390-5606 - - - - - - - - - - - -	KT	REPAIR OF PHOECCEL FUEL CELLS	GSA	1 QUART
ADHESIVE, ROOM TEMPERATURE CURE	MIL-A-9117  MIL-A-9117, CLASS L	8040-00-262-9060 8040-00-266-0839 8040-00-576-1781 - - - - - -	QT PT BT	NITRILE CELL RE- PAIR	GSA GSA GSA	2 OUNCES
ADHESIVE, ROOM TEMPERATURE CURING	MIL-A-46050 EASTMAN 910	8040-00-142-9193 - - - - - - - - - - - -	PT	CELL REPAIR	GSA	
ADHESIVE, VITHANE	82C32	8040-01-234-6624 - - - - - - - - - - - -	KT	FUEL CELL RE- PAIR	GSA	1/2 PINT
AIR COMPRESSOR	MC-1A MB-1 (ELECTRIC) MC-7	- - - - - - - - - - - - - - -	EA EA EA	PROVIDE AIR TO OPERATE EQUIP- MENT, TOOLS, RE- FER TO STOCKLIST FOR NSN.	FLZ FLZ FLZ	
AIR CONDITION- ER	A/M23C-4 (ELEC- TRIC) AM32C-5 (ELEC- TRIC) A-3 (GASOLINE) MA-1, MA-3 SERIES A/M32-10 SERIES	- - - - - - - - - - - - - - -	EA EA EA	CLIMATE CON- TROL AND VENTI- LATION OF AIRCRAFT AND FACILITIES, RE- FER TO STOCK- LIST FOR NSN.	FPZ FPZ FPZ	7 TON 11.5 TON 7 TON

Table 8-1. Materials and Equipment - Continued

AIR MOVER (EDUCTOR)	32119	4730-00-313-0680 - - - - - - - - -	EA	PURGING AND VENTILATING OF FUEL TANKS	S9C	
AIR PURIFIER CART		- - - - - - - - - - - -		REFER TO STOCK- LIST FOR NSN		
ALARM, COMBUS- TIBLE VAPOR (JP- 4), PORTABLE	50-7020	6665-01-225-4152 - - - - - - - - -	EA	USED FOR AREA AND TANK MONI- TORING	FPZ	
ALCOHOL	0E760 (DENA- TURED) TT-1-735 (ISOPRO- PYL)	6810-00-201-0907 6810-00-855-6160 - - - - - - - - -	CN CN	GENERAL PUR- POSE SOLVENT	S9G S9G	5 GALLON 5 GALLON
ALUMINUM FOIL	11-A-1876	9535-00-242-5661 9535-00-249-5785 9535-00-273-1815 - - - - - -	RO RO RO	USED FOR EXTER- NAL PATCHES ON FUEL TANKS	S9I S9I S9I	0.0015 0.0010 0.0020
ALUMINUM STOCK	QQ-A-225/6 (2020ST) QQ-A-225/7 (5052)	9530-00-236-1379 9530-00-236-0308 - - - - - - - - -	FT FT		S9I S9I	10' X 1.5" 10'X 1.5"
AMMONIUM HY- DROXIDE	0-A-451	6810-00-222-9643 - - - - - - - - - - - -	BT	LEAK TESTING FUEL CELLS	S9G	80 OUNCE

Table 8-1. Materials and Equipment - Continued

ANTISTATIC ADDITIVE	ASA-3	6850-01-064-6510 - - - - - - - - -	GL	ADDITIVE FOR MIL-SPEC PURGE	FLUID	S9G
BAG, PLASTIC, ELECTROSTATIC FREE	MIL-B-117	8105-01-268-4413 8105-01-268-4414 - - - - - - - - -	BX 50 EA BX 50 EA	PACKAGING FOAM MATERIAL	GSA	56" X 36" 48" X 48"
BLOWER FILTER ASSEMBLY	60D90327 (CAGE 98750)	- - - - - - - - - - - - - - -		LOCAL MANUFACTURE		
BLOWER, PNEUMATIC OPERATE	NF17-8	4140-01-105-6326 - - - - - - - - - - - -	EA	VENTILATING AND PURGING FUEL TANKS	S9G	8-INCH 1600 CEM
BRUSH	H-B-451	8020-00-721-9646 - - - - - - - - - - - -	EA	USED TO APPLY MIL-C-27725 AND OTHER COMPOUNDS	GSA	1" WIDE
BRUSH	H-B-118 (OX HAIR) H-B-391 (GOAT HAIR) H-B-420 VARNISH)	8020-00-224-8006 8020-00-224-8010 8020-00-205-1306 8020-00-260-1306 - - -	EA EA EA EA	ADHESIVE AND CEMENT APPLICATION	GSA GSA GSA GSA	3/8" WIDE 1" WIDE 1.5" WIDE 1" WIDE
BRUSH, SCRUB (STIFF BRISTLE)	H-B-1490	7920-00-619-9162 - - - - - - - - - - - -	EA	GENERAL PURPOSE	GSA	1.75"X4.5"

Table 8-1. Materials and Equipment - Continued

BUFFING STONE		- - - - - - - - -		BUFF CELL SURFACES PRIOR TO APPLICATION OF ADHESIVE, DRESS PATCHES AFTER PATCH APPLICATION OR BUFF FITTING FLANGES		3 INCH 7 INCH
BUNA-N NYLON SANDWICH MATERIAL	5200-5187	8305-00-396-1035 - - - - - - - - - - - -	YARD	PATCH MATERIAL FOR FUEL CELLS	JDC	40 INCH
BUNA-N SANDWICH MATERIAL	PF10056	9320-00-291-8468 - - - - - - - - - - - -	SH	PATCH MATERIAL FOR FUEL CELLS	S9G	36" X 36
BUNA-N TOP COAT (NITRILE)	MIL-S-4383	8030-00-664-4019 8030-00-664-4954 8030-00-857-3604 - - - - - -	PT QT GL	TOP COAT FOR BUNA-N PATCHES	GSA GSA GSA	
BUFFER, FUEL CELL		- - - - - - - - - - - - - - -		USED FOR HEAVY BUFFING SUCH AS THE REMOVAL OF FLANGES, OR FINISHED WORK ON BEADS		

Table 8-1. Materials and Equipment - Continued

CART FUEL TANK SERVICING	92103000	1740-01-326-0421 - - - - - - - - - - - -	EA		FPZ	
CART, NITROGEN SERVICING	MB-2 MB-3	- - - - - - - - - - - - - - -		USED TO INERT FUEL TANKS. RE- FER STOCKLIST		
CELLOPHANE, CLEAR	A-A-1742	8135-00-721-9878 - - - - - - - - - - - -	RO		GSA	6800'X13"
CEMENT, VITHANE	5923C	8040-00-518-3455 - - - - - - - - - - - -	KT	VITHANE CELL REPAIR	GSA	1/2 PT
CLEANING COM- POUND	MIL-C-87936, TY 1	6850-00-935-0996 - - - - - - - - - - - -	CN	GENERAL PUR- POSE AIRCRAFT CLEANER	GSA	5 GALLONS
CLEANING COM- POUND	P-C-435 A-A-1992	7930-00-531-7847 - - - - - - - - - - - -	CN	CLEANING FUEL DOCK FLOOR	GSA	25 POUNDS

Table 8-1. Materials and Equipment - Continued

CLEANING SOLVENT	P-D-680, TYPE I TYPE II TYPE III MIL-C-87937, TYPE I TYPE II	- - - - - - - - - - - - - - -		CLEANING FUEL TANKS. REFER TO STOCKLIST		
CLICK PATCH	231232 232155 2321546 231230	8040-01-107-3977 8040-01-107-3980 8040-01-107-3981 8040-01-107-4932 - - -	KT KT KT KT	FUEL TANK REPAIR	GSA GSA GSA GSA	HAT SHAPE FLAT, HEAT FLAT HAT SHAPE
CLOTH, CLEANING	RYMPLE 301 CCC-C-46, TY 1, CL 7	7920-01-004-7847 - - - 7920-01-180-0556 - - - - - -	RO BX	CELL AND TANK CLEANING	GSA GSA	
CLOTH, COTTON BUNTING	CCC-C-439	8305-00-286-5050 - - - - - - - - - - - -	YD	GENERAL PURPOSE CLEANING	S9T	12" WIDE
CLOTH, EMERY	P-C-451	- - - - - - - - - - - - - - -		REPAIR OF FITTINGS, REFER TO STOCKLIST		
CLOTH, HOLLAND, WHITE	MIL-C-17564	8305-00-361-4921 - - - - - - - - -	YD	USED FOR FUEL CELL REPAIR	S9T	1" WIDE
COAT, COLD WEATHER	MIL-C-43455	8415-00-782-2936 8415-00-782-2939 8415-00-782-2942 - - - - - -	EA EA EA	APPROVED OUTER GARMENT	S9T S9T S9T	SMALL MEDIUM LARGE

Table 8-1. Materials and Equipment - Continued

COATING, CORROSION CONTROL (ALODINE)	MIL-C-81706	8030-00-811-3723 - - - - - - - - -	BT	CORROSION PREVENTIVE FOR METAL/ALUMINUM SURFACES	GSA	2 POUNDS
COATING, CORROSION PROTECTION	MIL-C-27725, TY-2, CLB	8030-00-062-8449 - - - - - - - - -	KT	CORROSION PROTECTION OF METAL SURFACES	GSA	GALLON
COMBUSTIBLE GAS AND OXYGEN INDICATOR	51-08073	6665-01-294-8059 - - - - - - - - -	EA	TEST AND MONITOR OXYGEN AND AND LEL FUEL TANKS	FPZ	
CONDUCTIVITY METER	1152	6630-01-115-2398 - - - - - - - - - - - -	EA	TEST CONDUCTIVITY OF PURGE FLUID	FPZ	
CONVERSION COATING	MIL-C-81706 CHEMICAL KIT 120	8030-00-613-3131 8030-00-779-4699 - - - - - - - - -	KT	TREATMENT OF EXPOSED METAL AND ALUMINUM	GSA GSA	4 OUNCE
CORD, NYLON	MIL-C-5040, TYPE III	4020-00-240-2146 - - - - - - - - - - - -	SP	GENERAL PURPOSE AND FUEL CELL INSTALLATION	GSA	700 YARDS
COVER, FOOTWEAR		8430-00-508-0765 8430-00-508-0766 - - - - - - - - -	PR PR	LOCAL PURCHASE, USED TO COVER SHOES	JDC JDC	LARGE X-LARGE

Table 8-1. Materials and Equipment - Continued

CRAYON, MARK- ING	A-A-2360 TY1 SIZE B	7510-00-285-1731 - - - - - - - - - - - -	BX	GENERAL PUR- POSE	GSA	8 ASSORTED COL- ORS
CREAM, HAND CLEANING	A-A-268	8520-00-527-9942 - - - - - - - - - - - -	PT		GSA	
CUP, PAPER	UU-C-806	7350-00-290-0588 - - - - - - - - - - - -	BX	MIXING ADHE- SIVES	GSA	1200 EA
CLEANER, VACUUM PNEUMATIC	55-20 55-1AS	7910-00-632-9840 - - - - - - - - - - - -	EA	DEPUDDLING TANKS AND DEBRIS REMOVAL.	GSA	25 CFM
CONTROL BOX, LEAK TRACING DEVICE		- - - - - - - - - - - - - - -		USED WITH VAC- UUM CUP OR PRESSURE BOX TO DETECT LEAKS		
COVERALLS, WHITE	MIL-C-2202, TYPE II	8405-00-037-9184 8405-00-037-9234 8405-00-037-9247 8405-00-037-9280 8405-00-037-9281	EA EA EA EA EA	APPROVED OUTER GARMENT. CLOSED CUFLET AND ANKLET, NO POCKETS AND NO SPARK PRODUC- ING BUTTONS.	DLA DLA DLA DLA DLA	SMALL MEDIUM LARGE X-LARGE XX-LARGE
DESEALANT	MIL-D-9063, TYPE I	6850-00-861-9297 - - - - - - - - - - - -	GL	SOFTEN SEAL- ANTS TO FACILI- TATE SEALANT REMOVAL	GSA	

Table 8-1. Materials and Equipment - Continued

DETERGENT, NONIONIC	MIL-D-16791, TYPE I	7900-00-282-9699 - - - - - - - - - - - -	GL	GENERAL PUR- POSE AIRCRAFT CLEANER AND ALSO USED FOR LEAK DETECTION FLUID	GSA	
DYE, LIQUID	MIL-D-81289	6820-00-412-2296 - - - - - - - - -	GL	MIXED WITH FU- EL AND USED TO DETECT LEAKING FUEL TANKS	GSA	YELLOW
ETHYLENE GLY- COL		- - - - - - - - - - - - - - -		USED TO PRE- VENT WATER IN MANOMETER FROM FREEZING		
EPOXY TABS	EPOXY TABS TYPE O	8030-01-265-2895 - - - - - - - - - - - -	BX	FUEL TANK RE- PAIR	FLZ	24 EA
EPOXY, FAST SET- TING	04001	8040-00-292-2816 8030-01-265-2895 - - - - - - - - -	BX BX	REPAIR EXTER- NAL LEAKS	GSA FLZ	100 EA 24 EA
ETHYL-ACETATE	TT-E-51	6810-00-245-6694 - - - - - - - - - - - -	CN		S9G	5 GALLONS
ELECTRIC KNIFE		- - - - - - - - - - - - - - -		USED TO CUT FOAM MATERIAL. THE KNIFE SHOULD HAVE A TUNGSTEN CAR- BIDE BLADE		

Table 8-1. Materials and Equipment - Continued

FABRIC, PATCH MATERIAL	FT-237	8305-00-137-2566 - - - - - - - - - - - -	YD	FUEL CELL REPAIR	JDC	36" X 36 "
FABRIC, SHEET, NYLON SANDWICH	PF10034	8305-00-286-9905 - - - - - - - - - - - -	YD	CELL REPAIR	JDC	
FACE SHIELD	A-A-1770	4240-00-542-2048 - - - - - - - - - - - -	EA	FACE PROTECTION	GSA	
FOOT COVERING, THERMAL	M	8430-00-911-2458 8430-00-911-2459 8430-00-912-3771 - - - - - -	PR PR PR	APPROVED COLD WEATHER FOOT COVERING	JDC JDC JDC	MEDIUM LARGE X-LARGE
FLASHLIGHT	IN2-MS	6230-01-390-1727	EA	INSPECTION AND REPAIR		

Table 8-1. Materials and Equipment - Continued

FAN, VENTILATING	NF-14-2	4140-01-096-1596 - - - - - - - - - - - -	EA	AIR PURGE AND VENTILATION	S9G	12 INCH 2200 CFM
GAUZE PADS	MIL-C-87962, TY 2	7920-01-104-5406 - - - - - - - - - - - -	BG	FUEL TANK CLEANING	GSA	4" X 4" 200 ea
GLOVES, CHEMI- CAL RESISTANT	MIL-G-87066	8415-01-147-6263 8415-01-147-9540 8415-01-012-9294 8415-01-013-7382 8415-01-013-7384	PR PR PR PR PR	HAND PROTEC- TION DURING SOLVENT CLEAN- ING AND DEPUDDLING	S9T S9T S9T S9T S9T	SIZE 7 SIZE 8 SIZE 9 SIZE 10 SIZE 11
GLOVES, COTTON	A-A-1665	8415-00-268-8330 - - - - - - - - - - - -	PR	HAND PROTEC- TION	S9T	REGULAR
GLOVES, LEATHER PALM, KNIFE CUFF	JJ-G-451	8415-00-634-4661 - - - - - - - - - - - -	PR	HAND PROTEC- TION	GSA	REGULAR
GLYCERINE, USP GRAVITY 126	NDC00923-2031-16	6750-00-153-8220 - - - - - - - - - - - -	BT	LUBRICANT FOR FUEL CELLS	S9M	
GOGGLES	A-A-1110	4240-00-052-3776 - - - - - - - - - - - -	EA	EYE PROTECTION	GSA	

Table 8-1. Materials and Equipment - Continued

GROUND ROD, STEEL	MIL-S-6758	9510-00-528-4578 - - - - - - - - -	FT	GROUND RODS FOR AIRCRAFT AND EQUIPMENT	S91	10' X 1.5"DIAM- ETER
HEAD COVERING, SURGICAL		- - - - - - - - - - - - - - -		OBTAIN FROM BASE MEDICAL SUPPLY		
HEATING IRON	2F1-3-2572RVH 2F1-3-2572-1	4920-01-113-1833 4920-00-137-6916 - - - - - - - - -	EA EA	APPLY HEAT FOR CELL AND TANK REPAIRS	FPZ FPZ	290 DEG F 240 DEG F
HOT PATCH, AIRFOAM	53-52003-50	9320-01-187-8461 - - - - - - - - - - - -	FT	FUEL TANK RE- PAIR	S9G	1/4" X 52" X 72 YD
INSPECTION PENETRANT (ZYGLO)	ZL22	- - - - - - - - - - - - - - -		NDI TESTING		
KAYDRY TOWELS	UU-T-1447	7920-00-965-1709 - - - - - - - - - - - -	BX	GENERAL PUR- POSE CLEANING	GSA	90 PER PACKAGE, 15 PACKAGES PER BX
KNEE PAD	A-A-1748	4240-00-595-3861 - - - - - - - - - - - -	PR	KNEE PROTEC- TION DURING TANK MAINTEN- ANCE	GSA	

Table 8-1. Materials and Equipment - Continued

LEAK DETECTION COMPOUND, (FLUID)	372E	6850-00-935-4068 - - - - - - - - -	CA	FUEL TANK LEAK DETECTION.	GSA	FOUR 12oz BOTTLES
LEAK DETECTION POWDER	LD-4 ELDORADO (55208)	6850-00-909-3121 - - - - - - - - -	CA	FUEL TANK LEAK DETECTION	S9G	6 OUNCES
LIGHT, EXPLOSION PROOF	MIL-L-83762 MIL-W-21751	6230-00-042-5671 6230-00-283-9671 - - - - - - - - -	EA EA	APPROVED LIGHTING FOR HAZARDOUS AREAS	S9G S9G	26 X 3.5 19 X 1.8
MANOMETER, WATER	68E36424	4920-00-834-3992 - - - - - - - - - - - -	EA	LOCAL MANUFACTURE, USED AS A PRESSURE RELIEF AND TO MEASURE VACUUM OR AIR PRESSURE ON A TANK.	FPZ	
MARKER, FELT TIP	GG-M-114	7520-00-558-1501 7520-00-973-1059 - - - - - - - - -	SE DZ	GENERAL PURPOSE MARKING	GSA GSA	MULTICOLOR BLACK
METHYL, ETHEYL KETONE (MEK)	TT-M-261	6810-00-281-2785 - - - - - - - - - - - -	GL	CLEANING FUEL TANKS	S9G	
METHYL, ISOBUTYL KETONE (MIBK)	ASTM D1153	6810-00-286-3785 - - - - - - - - - - - -	GL	CLEANING FUEL TANKS	S9G	

Table 8-1. Materials and Equipment - Continued

MANOMETER, WATER	F52828-116	4920-00-793-0650 - - - - - - - - - - - -	EA	SAFETY DEVICE TO PREVENT OVER PRESSURI- ZATION OF CELLS AND TANKS AND TO MEASURE AIR PRESSURE	FPZ	
MIXING MACHINE	285	4940-00-996-1566 - - - - - - - - - - - -	EA	MIX SEALANTS AND ADHESIVES.	FPZ	
NAPTHA	TT-N-95	0023-88-119- - - - - - - - - - - - -	GL	CLEANING FUEL TANKS	GSA	
NOZZLE, CAULKING GUN	8630-9 8646 8690 600-E	5120-00-966-5376 5120-00-966-5374 5120-00-966-8243 5120-00-670-1187	EA EA EA EA	USED TO APPLY FUEL TANK SEAL- ANTS	GSA GSA GSA GSA	1.8" SLOT 3/4 " SLOT 0.094 DIA EXTENSION
NOZZLE, CAULKING GUN	252 254 410 410-45	5120-00-167-0151 5120-00-673-1885 5120-00-801-0949 5120-00-055-4063	EA EA EA EA	APPLY FUEL TANK SEALANT	GSA GSA GSA GSA	1/16" X 2" 1/8" X 2" 1/32" X 4 " 1/32" X 4 "
NOZZLE, CAULKING GUN	420 420-45 430 430-45	5120-00-042-6577 5120-00-670-1185 5120-00-967-8151 5120-00-055-4062 - - -	EA EA EA EA	APPLY FUEL TANK SEALANT	GSA GSA GSA GSA	1/16" X 4" 1/16" X 4" 3/32" X 4" 3/32" X 4 "

Table 8-1. Materials and Equipment - Continued

NOZZLE, CAULKING GUN	440 440-45-3 620 640-45	5120-00-773-3791 5120-00-670-1186 5120-00-167-0152 5120-00-966-5373	EA EA EA EA	APPLY FUEL TANK SEALANT	GSA GSA GSA GSA	1/8" X 4" 1/8" X 4" 1/16" X 6" 1/16" X 6"
NOZZLE, CAULKING GUN	640 640-30-2-7-8 820 820-45	5120-00-822-7194 5120-00-167-0153 5120-00-966-8270 5120-00-966-5371 - - -	EA EA EA EA	APPLY FUEL TANK SEALANT	GSA GSA GSA GSA	1/8" X 4" 1/16" X 8" 1/16" X 8" 1/16" X 8"
NOZZLE, CAULKING GUN	980 1004	5120-00-055-4055 5120-00-055-4054 - - - - - - - - -	EA EA	APPLY FUEL TANK SEALANT	GSA GSA	1/16" X 10" 1/8"X 10"
NOZZLE, CAULKING GUN, FILLETING, DUCKBILL	8613 8615 974 8648	5120-00-966-5379 5120-00-966-5378 5120-00-775-1670 5120-00-966-5375 - - -	EA EA EA EA	APPLYING SEAL- ANT	GSA GSA GSA GSA	5 X 3/8 4 X 1/2 4 3/8X 3/4 5 1/8 X 3/4
NOZZLE, CAULKING GUN, FILLETING, WIDE	8630 8630-9	5120-00-966-5317 5120-00-966-5376 - - - - - - - - -	EA EA	USED WITH SEAL- ANT GUN	GSA GSA	47/8X17/8 41/4X13/4
NOZZLE, INJECTION	C-13117-1 C-14117-2 C-13117-3	5120-00-961-4996 5120-00-954-4995 5120-00-961-4997 - - - - - -	EA EA EA EA	APPLY FUEL TANK SEALANTS	FLZ FLZ FLZ	3/32 INCH 1/8 INCH 3/16 INCH
NOZZLE, CAULKING GUN, FILLETING, BENT	226856 1010-45	5120-00-055-4056 - - - - - - - - -	EA	SEALANT APPLI- CATION.	GSA	10 x 1/32

Table 8-1. Materials and Equipment - Continued

NOZZLE, CAULKING GUN, FILLETING, FLARED	220568 8608	5120-00-966-5381 - - - - - - - - - - - -	EA	SEALANT APPLI- CATION.	GSA	4 X 3/8
NOZZLE, CAULKING GUN, FILLETING, FLAT	220569 8607	5120-00-966-8244 - - - - - - - - - - - -	EA	SEALANT APPLI- CATION.	GSA	6 X 1/4
NOZZLE, CAULKING GUN, FILLETING, STRAIGHT	220565 987	5120-00-055-4058 - - - - - - - - - - - -	EA	SEALANT APPLI- CATION.	GSA	10 X 1/32
OIL, LUBRICATING	VV-L-825	9150-00-265-7301 - - - - - - - - - - - -	QT	FUEL CELL PRES- ERVATION	S9G	
OIL, LUBRICATING	MIL-L-6082, GR 1065	- - - - - - - - - - - - - - -		FUEL SYSTEM PRESERVATION, REFER TO STOCK- LIST		
OXYGEN ANALYZER	115583	6630-00-604-2658 - - - - - - - - -	EA	MEASURE OXY- GEN CONCENTRA- TION OF CELLS AND TANKS	N35	0 -100%
ONTARIO KNIFE	GGG-C-746	7340-00-680-0863 - - - - - - - - - - - -	EA	THE KNIFE IS USED TO CUT EX- PLOSION SUS- PRESSENT FOAM.	GSA	12 in

Table 8-1. Materials and Equipment - Continued

PAINT	A-A-665	8010-00-584-3150 - - - - - - - - - - - -	PT	STENCIL FUEL CELLS	GSA	SPRAY
PAINT, BUNA VINYLITE LACQUER		8030-00-166-8813 - - - - - - - - - - - -	CN	SELF SEALING CELL REPAIR TOPCOAT	GSA	5 GALLONS
PAPER, KRAFT	A-A-203	8135-00-160-7757 - - - - - - - - - - - -	RO	PACKAGING FUEL CELL	GSA	1228' X 2'
PARKA	MIL-P-6279	8415-00-376-1668 8415-00-376-1672 8415-00-376-1710 - - - - - -	EA EA EA	APPROVED GAR- MENT FOR EX- TREME COLD WEATHER	S9T S9T S9T	SMALL MEDIUM LARGE
PENCIL, AIR- CRAFT MARKING	MIL-P- 83953, TY1, CL B COLOR- BRITESILVER2101	7510-00-537-6935 7510-00-537-6930 7510-00-111-6425 - - - - - -	DZ DZ DZ	MARKING FUEL LEAKS	GSA GSA GSA	RED YELLOW SILVER
PETROLATUM	VV-P-236, TY V, CL 2	9150-00-250-0926 - - - - - - - - - - - -	CN	GENERAL PUR- POSE	GSA,	1.75 LBS
PHE- NOLPHTHALIEN	O-C-215	68-00-223-7612 - - - - - - - - - - - -	BT	FUEL CELL LEAK DETECTION	S9G	100 GRAMS

Table 8-1. Materials and Equipment - Continued

PLENUM CHAMBER	57D6188	--- --- --- --- ---	EA	LOCAL MANUFACTURE. USED TO ADAPT NON-EXPLOSION PROOF HEATERS TO SUPPLY HEATED VENTILATION AND AIR PURGE	FPZ	
PUTTY, ZINC CHROMATE	MIL-P-8116	8030-00-145-0300 --- --- --- ---	CN	USED TO RETAIN LEAK TEST FLUIDS	GSA	2 POUNDS
PROBE, UL- TRASONIC	2000	6635-01-156-3927 --- --- --- ---	EA		FPZ	
PUMP, AMBIENT AIR, BREATHING	NF-15-3	4310-01-084-9665 --- --- --- ---	EA	AIR SUPPLY FOR RESPIRATORS.	S9C	
PUMP, BREATH- ING AIR, ELEC- TRIC, EXPLOSION PROOF	NF19-1S	4310-01-135-7607 --- --- --- --- --- --- ---	EA	AIR SUPPLY FOR RESPIRATORS	S9C	
RELEASE FILM (MYLAR)	L-P-519	9330-00-579-6217 - - -	SH	FUEL TANK RE-PAIR	S9G	24" X 30"

Table 8-1. Materials and Equipment - Continued

RESPIRATOR		--- --- --- --- ---		REFER TO AFOSH 48-1, LOCAL BIO-ENVIRONMENTAL ENGINEER FOR RESPIRATOR SELECTION		
RETAINER, FIL- LETING GUN	606 220256 612	5120-00-693-8070 5120-00-693-8069 5120-00-693-8071 --- ---	EA EA EA	USED WITH SEAL- ANT GUN	FLZ GSA GSA	
SAFETY SIGN	7331119-01	- - - - - - - - - - - -	EA	"DANGER OPEN FUEL TANKS" USED TO MARK EXTERIOR OF FU- EL SYSTEM RE- PAIR AREAS AND FACILITIES	FLZ	
SAFETY STREAMER, YEL- LOW	9144675-01 9144675-03 9144675-05	8345-01-355-2379 8345-01-355-2378 8345-01-355-2380	EA EA EA	"REMOVE BEFORE FUELING/ DEFUELING"	JDC JDC JDC	12 INCH 24 INCH 36 INCH
SAFETY STREAMERS, RED	MS51700	- - - - - - - - - - - -		"REMOVE BEFORE FLIGHT" REFER TO STOCKLIST		
SEALANT CARTRIDGE	250-CP6 250-C6 250-CP- 2 1/2	5120-00-670-3294 5120-00-673-1886 5120-00-670-3295	EA EA EA	USED WITH SEAL- ANT GUN.	GSA GSA GSA	6 OUNCE 2.5 OUNCE
SEALANT GUN	509	5130-00-050-9886 --- --- ---	EA	APPLY NON-CUR- ING SEALANTS.	GSA	
SEALANT GUN	250 750 223 225 507A	5130-00-341-1931 5130-00-677-5722 5130-00-345-1179 4920-00-345-1178 5120-00-677-7439	EA EA EA EA EA	APPLY CURING TYPE SEALANTS	GSA GSA GSA GSA GSA	

Table 8-1. Materials and Equipment - Continued

SEALANT MIXING MACHINE	285	4940-00-996-1566 --- --- --- ---	EA	MIX CURING TYPE SEALANTS	FPZ	
SEALING COMPOUND (LOCTITE)	MIL-S-22437 GR A	8030-00-844-3821 --- --- --- ---	BT	FASTENER SEALING	GSA	50cc (RED)
SEALING COMPOUND, ALKYDESIN (OYLTITE STIK)	OLYTITESTIK	8030-935-5841 --- --- --- ---	EA	FUEL TANK REPAIR	GSA	1 OUNCE
SEALING COMPOUND, CLASS B-2	PR1826	8030-01-290-5138 8030-01-290-5139 --- --- ---	KT KT	FUEL TANK REPAIR	GSA GSA	2.5 OUNCE 6 OUNCE
SEALING COMPOUND, CORROSION INHIBITED	PR1426 TYPE I 1/2 TYPE I-2 TYPE II-1/2 TYPE II-2 TYPE-III-1	8030-00-008-7207 8030-00-008-7196 8030-00-008-7198 8030-00-009-5023 8030-00-008-7203	KT KT KT KT KT	FUEL TANK REPAIR	GSA GSA GSA GSA GSA	1 PINT 1 PINT 1 PINT 1 PINT 1 PINT
SEALING COMPOUND HIGH TEMPERATURE, POLYSULFIDE	MIL-S-83430 TYPE A-1/2 TYPE A2 TYPE B-1/2 TYPE B2	--- 8030-00-602-0107 8030-00-602-0049 8030-00-348-7888 8030-00-485-3237	KT KT KT KT	FUEL TANK REPAIR	GSA GSA GSA GSA	1/2 PINT 1/2 PINT 1 PINT 1 PINT
SEALING COMPOUND, HIGH TEMPERATURE, POLYSULFIDE	MIL-S-83430 TYPE B-1/2 TYPE B2	--- 8030-00-602-0039 8030-00-560-8758	KT KT	FUEL TANK REPAIR	GSA GSA	1/2 PINT 1/2 PINT

Table 8-1. Materials and Equipment - Continued

SEALING COM- POUND, LOW TEMPERATURE CURE, CLASS A-1	MIL-S-83318	8030-00-474-1419 --- --- ---	KT	FUEL TANK RE- PAIR	GSA	6 OUNCE
SEALING COM- POUND, NON- CURING	MIL-S-85344	8030-01-043-2295 --- --- ---	CA	FUEL TANK RE- PAIR	GSA	1/2 PINT
SEALING COM- POUND, NONCUR- ING	94-031	8030-00-145-0310 --- --- ---	CA	FUEL TANK RE- PAIR	GSA	1/2 PINT
SHEET, BUNA-N	W878	9230-00-202-1464 --- --- ---	YD	FUEL CELL RE- PAIR	S9G	0.035" X 30 YARDS
SHEET, CLOTH COATED	MIL-C-82255, TY IV	8305-00-244-0310 --- --- ---	YD	FUEL CELL RE- PAIR	S9T	0.025"
SHEET, RUBBER	MIL-R-6855	9320-00-180-3259 --- --- ---		FUEL CELL RE- PAIR	S9G	
SHOES	A-A-50137 (GYM) MIL-S-3794 (SAFE- TY)	--- --- --- ---		REFER TO STOCK- LIST FOR NSN.	S9T S9T	

Table 8-1. Materials and Equipment - Continued

SHOT BAG		---		LOCAL MANUFACTURE TO DIMENSIONS AS REQUIRED		
SKIN PROTECTIVE CREAM	P-S-411, TYPE 3 STARLEE INVISIBLE GLOVES	6850-00-244-4892 --- --- ---	LB	USED AS A BARRIER UNDER GLOVES	S9G	1 POUND
SOAP	COMMERCIAL, LIQUID, NON-ABRASIVE DISH OR LAUNDRY SOAP/ DETERGENT	--- --- ---		FUEL CELL CLEANING		
SOLDERING IRON	W-S-570	--- --- --- ---		HEAT SOURCE FOR CELL AND TANK REPAIR. REFER TO STOCK-LIST		
SPONGE, CELLULOSE	L-S-00626, TYPE II CLASS 1, SIZE 3	7920-00-559-8462 --- --- ---	BX	FUEL TANK DEPUDDLING	GSA	2"X 4"X6 " CONTAINS 60 EA
SEALING COMPOUND, CORROSION INHIBITED	PR1426 TYPE IV-12	8030-00-008-7205 --- --- ---	KT	FUEL TANK REPAIR	GSA	1 QUART
STATIC METER	SWE 1125	--- --- ---	EA		FPZ	

Table 8-1. Materials and Equipment - Continued

STITCHER	ROLLER HORIZONTAL OFF- SET VERTICAL OFF- SET	--- --- --- --- ---		LOCAL MANUFAC- TURE, REFER TO T.O. 1-1-3 FOR DRAWINGS		
SWEATPANTS, COTTON BLEND SILVER/GRAY COLOR	BBB-S-1269	8415-00-268-8180 8415-00-268-8179 8415-00-268-8178 --- ---	EA EA EA	APPROVED OUTER GARMET	S9T S9T S9T	SMALL MEDIUM LARGE
SWEATSHIRT, COTTON BLEND, SILVER/GRAY COLOR	BBB-S-1268	8415-00-269-0403 8415-00-262-1534 8415-00-262-1535 8415-00-262-1536 ---	EA EA EA EA	APPROVED OUTER GARMET	S9T S9T S9T S9T	SMALL MEDIUM LARGE X-LARGE
SPATULA SET	22624 TS1275-K	5120-00-056-3237 --- --- --- ---	SE	SEALANT APPLI- CATION	GSA	Set of 3
TAPE, ALUMI- NUM, PRESSURE SENSITIVE	A-A113	7510-00-684-8803 --- --- --- ---	RO	LEAK REPAIR	GSA	180' X 2"
TAPE PACKAGING	PPP-T-42	7510-00-266-6710 --- --- --- ---	RO	PACKAGING AND MASKING	GSA	2" WIDE 60 YARDS TAN
TAPE, WATER- PROOF	PPP-T-60	8135-00-663-9052 --- --- --- ---	RO	PACKAGING AND MASKING	GSA	1" WIDE

Table 8-1. Materials and Equipment - Continued

TEMPORARY RE-PAIR KIT (COM-PAIR INJECTION KIT)	D236	4920-00-485-1213 --- --- ---	KT	APPLY TEMPORA- RY REPAIRS	FPZ	
THERMAL UN- DERWEAR COT- TON BOTTOM	A-A-50378	8415-00-782-3226 8415-00-782-3227 8415-00-782-3228 --- ---	PR PR PR	APPROVED COLD WEATHER	S9T S9T S9T	SMALL MEDIUM LARGE
THERMAL UN- DERWEAR, COT- TON TOP	A-A-50383	8415-00-270-2012 8415-00-270-2013 8415-00-270-2014 --- ---	EA EA EA	APPROVED COLD WEATHER	S9T S9T S9T	SMALL MEDIUM LARGE
THERMOMETER BIMETALLIC	310F	6685-00-996-8899 --- --- --- ---	EA	GENERAL PUR- POSE	S9G	0 TO 300 F
TOLUENE	TT-T-548	6910-00-290-0048 --- --- --- ---	CN	CLEANING SOL- VENT	GSA	5 GALLONS
TONGUE DEPRESSOR	GG-D-226, TY II	6515-00-324-5505 --- --- --- ---	BX		S9M	100 EA

Table 8-1. Materials and Equipment - Continued

UNDERSHIRT	MIL-U-44096	8420-00-543-6648 8420-00-543-6649 8420-00-543-6650 --- ---	EA EA EA		DLA DLA DLA	X-LARGE XX-LARGE XXX-LARGE
UNDERSHIRT, QUARTER SLEEVE, WHITE	MIL-U-44096, TYPE I, Class 1.	8240-00-543-6634 8240-00-543-6644 8240-00-543-6645 8240-00-543-6646 8240-00-543-6647	EA EA EA EA EA	TO BE WORN UNDER COVER- ALLS, SWEAT SHIRTS OR OTHER APPROVED OUTER GAR- MENTS.	DLA DLA DLA DLA DLA	XX-SMALL X-SMALL SMALL MEDIUM LARGE
UTILITY PAIL	B12R	7420-01-150-0716 --- --- --- ---	EA	GENERAL PUR- POSE.	GSA	3 GAL
VACUUM CLEAN- ER PNEUMATIC	SS-55TC	7910-00-632-9840 7910-21-908-3235 --- --- ---	EA EA	USED FOR DEBRIS REMOVAL AND DEPUDDLING FUEL TANKS	GSA GSA	
VACUUM CUP		--- --- --- --- ---		THIS CUP IS USED TO CONFIRM RE- PAIRS. THE CUP IS USED IN CON- JUNCTION WITH THE LEAKAGE TRACING DEVICE.		

Table 8-1. Materials and Equipment - Continued

VACUUM/PRES-SURE CUP		--- --- --- --- ---		ALSO CALLED A DOUBLE CUP. THIS CUP HAS A VACUUM SEG-MENT TO HOLD THE CUP IN PLACE AND A PRESSURE SEG-MENT TO INJECT DYE INTO THE LEAK PATH		
WATER DIS-TILLED	O-B-41	6810-00-297-9540 --- --- --- ---	DR		S9G	5 GALLONS

## APPENDIX A

### SHELF LIFE UPDATE METHOD

#### BASE LEVEL (FIELD)

**A-1 SHELF LIFE UPDATING:** To be used for MIL-S-8802, MIL-S-83430, MIL-S-81733, and AMS 3276 fuel tank sealants. Each batch of material should be tested separately. Randomly select one sealant kit per batch for testing.

#### **A-2 PERFORM VISUAL INSPECTION:**

**A-2.1 All Packaging Except Two-Component Kits.** Visually examine containers to insure the lid seal has not been broken. Discard both base and accelerator if the seal on either is broken.

**A-2.1.1** Open both containers (base and accelerator) and check for skinning, if skinning has occurred in either base or accelerator, discard both.

**A-2.1.2** Stir both base and accelerator. Both materials should blend well and without lumps or streaks. Discard both if either material has any evidence of lumps or streaks.

**A-2.2 Two Component Kits.** Check cartridge for evidence of cracks or loss of material.

#### **A-3 PERFORMANCE TESTING:**

**A-3.1** Mix material in accordance with manufacturer's instructions. Material should mix well with no streaks.

**A-3.2** Apply mixed material to an aluminum panel coated with MIL-C-27725, fuel tank coating. Form a bead of material approximately 1/8 to 1/4

inch high and three inches to six inches long. Material should flow well and wet the surface easily. Tool bead to make sure no air is entrapped. Discard if material does not flow easily or wet the surface easily. Record time and date.

**A-3.3** After the rated tack-free time (paragraph 6-7.5 and 6-7.6) place a piece of polyethylene plastic film into the sealant. Quickly remove the plastic film from the sealant. No sealant should remain on the film. If any sealant transfers discard the sealant.

**A-3.4** After the rated cure time (paragraph 6-7.7) the sealant should be firm but flexible. Push against the sealant with a tongue depressor or other blunt instrument. Sealant should adhere well to the surface. Any indication of no adhering is cause for rejection.

#### **A-4 SHELF LIFE EXTENSION.**

**A-4.1** If all tests are passed, shelf life for material of that batch can be extended three months from the date of testing. All containers should be marked with the new shelf life date.

**A-4.2** If any failure in visual inspection or testing is observed, all material from that batch should be discarded.

**A-4.3** Shelf life can be extended a maximum of two times. After that, material should be discarded.



## GLOSSARY

**PURPOSE.** This glossary contains a list of words and phrases and their definitions as they relate to this technical order.

## A

**ABRADE**--To prepare a surface for cementing or sealing by roughening.

**ABRADED AREA**--Scuffed area where the surface has been roughened either in preparation for cementing or sealing or accidental damage from, such as chafing.

**ABSOLUTE SEALING**--Level of sealing for integral tanks which requires all seams, voids, slots, holes, and fasteners penetrating the tank to be sealed leak free.

**ACCELERATOR**--The curing agent used in multiple part curing type sealants.

**ADHESION**--The property of a material that makes it stick to another material.

**ADHESION PROMOTER**--Material applied to a surface to enhance curing type sealant adhesion.

**ADHESIVE SEALING**--A method of sealing faying surfaces using a structural adhesive to form a primary seal.

**AFFF**--Aqueous Film Forming Foam. A fire suppression agent.

**AFOSH-STD**--Air Force Occupational Safety and Health Standard

**ATTENDANT**--A trained individual outside of the confined space who acts as the observer of the entrant.

## B

**BASE COMPOUND**--The major component of a multiple part curing type sealant, usually synthetic rubber.

**BLISTER**--A raised spot on the surface or a separation between the plies of a fuel cell which usually forms a void or air filled space.

**BLADDER TANK**--See FUEL CELL

**BONDING**--The equalization of static electricity charges between two or more objects.

## B (Cont)

**BOUNDARY STRUCTURE**--The fuel tight primary structure of an integral tank which forms the tank boundaries. Comprised of skin panels, bulkheads, and spars.

**BUFFING**--A method of abrasion which forms a roughened or velvety surface.

## C

**CAVITY**--The structural members surrounding a fuel cell which act as a secondary container and help support the fuel cell.

**CENTERLINE GROOVE**--An injection sealing groove machined along the fastener line.

**CHANNEL**--A passage formed by structural discontinuity or a groove machined into a faying surface.

**CHANNEL SEAL**--See INJECTION SEAL

**CHECKING, WEATHERING or OZONE**--Short small cracks on the surface of a fuel cell, generally caused by environmental conditions.

**COHESION**--The property of a material that holds it together.

**CONFINED SPACE**--Any space with limited ingress and egress which can be bodily entered.

**CORROSION PREVENTIVE COMPOUND**--A material applied to a surface to provide corrosion resistance.

**CPR**--Cardiopulmonary Resuscitation.

**CRAZING**--A surface irregularity characterized by many hairline indentions or ridges.

**CURE**--The metamorphosis of a curing type sealant from a soft state to a firm rubbery condition.

## D

**DEPUDDLING**--The removal of fuel or other liquid puddles from cells or tanks. Depuddling is usually accomplished with a sponge and bucket or air operated vacuum system.

**DESEAL**--Removal of sealant from a surface.

**DESEALANT**--A material used to remove or loosen some curing type sealants.

## GLOSSARY - Continued

### D (Cont)

**DELAMINATION**--The separation of plies on a fuel cell or composite material.

**DESIGNATED ALTERNATE ENTRY AUTHORITY**--An individual designated by the entry authority to issue field permits. This individual shall be listed on the master permit.

**DOME NUTS**--Plate nuts with a mechanical seal at the base and a cap over the top to provide a fuel tight seal.

**DRAINING**--The removal of fuel or other liquids from cells or tanks via the aircraft fuel system drains.

### E

**ENCLOSED AREA**--A space with limited ingress and egress which is not large enough to be bodily entered. Enclosed areas will be treated the same as confined spaces.

**ENTRANT**--an employee who is trained and authorized to enter a confined space.

**ENTRY**--Any act which results in any part of an employee's body breaking the plane of the opening of a confined space or enclosed area. Includes any ensuing work in the confined space or enclosed area.

**ENTRY AUTHORITY**--The individual authorized by the LG/CC to issue field permits. Usually the fuel element chief.

**ENTRY AUTHORITY AUTHORIZATION LETTER**--A letter issued by the Logistics Group Commander with coordination from Ground Safety, Bioenvironmental Engineering Services, and the Fire Department qualifying the Entry Authority and Designated Alternate Entry Authority and the conditions under which the Field Permit may be issue. Formerly called the Master Permit.

**ENTRY CHIEF**--The person designated to be in charge of the tank entry. The entry chief has control overall facets of the entry. Any member of the entry team (entrant, attendant, or runner) may be the entry chief. The attendant is usually the entry chief.

**ENTRY PERMIT SYSTEM**--A system for ensuring safe entry in a confined space, i.e. integral tank or fuel cell.

### E (Cont)

**ENTRY SAFE**--Conditions at which it is safe to enter a confined space. In general conditions are: 10% LEL (20% LEL for foam removal), oxygen level between 19.5% and 23.5% and toxicity limits within the limits prescribed on the master permit.

**EMERGENCY COMMUNICATIONS**--Any type of communications link which is available for requesting emergency assistance.

**EXPLOSIONPROOF APPARATUS**--An apparatus enclosed in a case that is capable of withstanding an explosion of a specified gas or vapor which may occur within it and of preventing the ignition of a specified gas or vapor surrounding the enclosure by sparks, flashes or explosion of the gas or vapor within and which operates at such an external temperature that a surrounding flammable atmosphere will not be ignited thereby.

**EXTERNAL MOUNTED FUEL SYSTEM COMPONENT**--A fuel system, or related, component mounted in such a manner that it is not necessary to enter a fuel cell or integral tank (other than hand entry) to remove replace or repair the component.

### F

**FAYING SURFACE**--Surfaces which are extremely close together.

**FAYING SURFACE SEAL**--A seal between mating surfaces to prevent corrosion or to prevent fuel from traveling along or through mating surfaces.

**FIELD PERMIT**--The permit authorizing entry into a confined space.

**FILLET SEAL**--A primary seal applied along the edges of faying surfaces and over, along and between installed parts.

**FIRE SAFE**--An atmospheric concentration of combustible vapors equal to or less than 20% LEL.

**FIRST FILLET (UNDERSIZE FILLET)**--The first small bead or undersize fillet of curing type sealant applied to a surface.

**FIT JIG**--A structure built to duplicate a fuel cell cavity. Used to ensure cell fitting locations and hangars are correctly positioned.

**FRIED or SCARRED CONDITION**--Depressed areas in fuel cell liner, caused by air or solvent vapor trapped between the liner material and building form.

## GLOSSARY - Continued

## F (Cont)

**FUEL CELL**--A flexible bag contoured to the shape of a fuselage or wing cavity and designed to contain a liquid. Three basic types of cells are bladder, self-sealing and a combination.

**ACTIVATION**--A condition which occurs in self-sealing cells when fuel contacts the sealant causing the sealant to swell.

**BAFFLE SHOES**--Fabric straps attached to the liner of a cell to secure the internal baffles to cell walls.

**FITTING**--Attaching points of a fuel cell for functional equipment such as pumps, vents or outlets.

**HANGAR SUPPORT**--An exterior attachment to a fuel cell, usually made of loop of webbing, used to attach fuel cell to aircraft structure for support.

**HANGAR STRAP**--An exterior attachment to a fuel cell, usually made of loop of webbing, used to support a fuel cell installed in aircraft and storage containers.

**INNER LINING**--First ply of fuel cell material, functions as a support and protects nylon barrier. May be constructed of fabric or rubber.

**SELF SEALING**--A cell designed to automatically seal itself when punctured.

**SELF SUPPORTING**--A cell designed to support itself without support from surrounding structures.

**SEPARATIONS**--Areas of non-adhesion between cell plies but exhibit no evidence of trapped liquid.

**FUEL LEAKS**--Refer to T.O. 00-25-172 for more information on Class 1,2, and 3 leaks.

**CLASS 1**--Involve an area less than two feet in any direction.

**CLASS 2**--Involve an area not over 10 feet in any direction, or not over 50 square feet.

**CLASS 3**--Involve an area over 10 feet in any direction, or over 50 square feet.

**FULL-BODIED FILLET**--A bead of curing-type sealant conforming to final required dimensions of fillet seal.

## G

**GROOVE SEAL**--See INJECTION SEAL.

**GROUNDING**--The removal of a static electrical charge from the surface of an object by connecting the object to an approved ground.

## I

**IDLH**--Immediately Dangerous to Life and Health, any condition which poses immediate threat to life or may result in acute severe health effects.

**INERTING**--The replacement of oxygen in the atmosphere with a gas to the point the atmosphere will not support combustion or explosion.

**INJECTION SEAL**--A seal accomplished by injecting a curing type or non-curing type sealant into holes, channels and other voids in fuel tank boundaries.

**INTEGRAL FUEL TANK**--Any cavity designed to hold fuel or other liquid.

**INTERFERENCE SEAL (FASTENER)**--A seal produced by metal to metal contact between a fastener and its mating hole.

**INTRINSICALLY SAFE**--Equipment and wiring that is not capable of producing sufficient electrical or thermal energy under normal or abnormal conditions to cause ignition of a flammable or combustible atmospheric mixture in its most easily ignitable concentration.

**ISOLATION SEAL**--A repair seal composed of structure, fasteners, and sealing materials which re establishes seal continuity and are in immediate contact with the fuel being contained.

A short seal installed on some tanks to isolate potential leakage, such as channeling of fuel along a leak path between structural members.

## L

**LAP SEAM**--A seam made by placing the flat edge of one piece of material over the edge of a second piece of material or over itself.

**LEAK PATH**--The path or trail leaking fuel follows from the leak source to the leak exit point.

## GLOSSARY - Continued

### L (Cont)

**LEAK SOURCE**--The place inside the tank where the leak originates.

**LEAK EXIT**--The point outside of a tank where a leak first appears.

**LEL**--Lower Explosive Limit is the lowest concentration of flammable or combustible vapors which can be ignited by a spark or flame.

### M

**MASTER PERMIT**--See ENTRY AUTHORITY AUTHORIZATION LETTER.

**MECHANICAL SEAL**--A seal produced by deformation of an elastic material due to interference at the contacting surfaces as in access doors or O-rings.

**MSDS**--Material Safety Data Sheet. Supplied by manufacturers to inform customers of hazards associated with their product.

### N

**NFPA Codes**--National Fire Protection Association Codes. A list of accepted practices to prevent fires. In general the Air Force accepts most of the codes.

### O

**OFF-PRESSURE SEAL**--A level of sealant applied outside of the seal plane.

**OSHA-STD**--Occupational Safety and Health Standards. The federal law covering worker and work-place safety/health.

### P

**PARTING AGENT**--A material used to prevent sealant from sticking to a surface.

**PERMANENT REPAIR**--A repair which returns a tank to a no leak condition.

**PERMIT REQUIRED CONFINED SPACE**--All integral tanks and fuel cells capable of being entered.

**PLASTICIZER**--An additive in rubber or plastic to increase the pliability or low temperature flexibility of the finished product.

### P (Cont)

**PPE**--Personal Protective Equipment. Refer to AFOSH 127-31.

**PLY**--A layer of basic fuel cell construction, either fabric or non-fabric.

**POSTASSEMBLY SEAL**--A seal that has been applied after the tank structure has been assembled. (See FILLET SEAL and INJECTION SEAL).

**PRECOAT SEAL**--The application of a coat of brushable sealant to serve as a base for fillet seal (see BRUSHCOAT).

**PREPACK SEAL**--A seal applied during tank assembly by packing inside and areas which are not readily accessible without disassembly with a curing type sealant.

**PRIMARY SEAL**--A seal which by itself, can contain fuel and requires no additional seals (see ABSOLUTE SEAL).

**PURGE**--A process which removes flammable or combustible fluids and vapors.

### R

**REDUNDANT SEAL**--The use of two primary sealing systems, or seals in which one acts as a backup for the other.

**RESCUE TEAM**--A group of two or more specially trained employees (preferable fuel system repair specialist (AFSC 2A6X4 or equal)) who are designated to rescue entrants from confined spaces.

### S

**SCOTCHWELD SEAL**--A General Dynamics sealing system design using AF-10 structural adhesive.

**SEALANT, CURING TYPE**--A multiple part sealant which changes, after mixing, from a soft state to a rubber-like tack-free condition.

**SEALANT, NON-CURING TYPE**--A sealing material that does not cure with time, retaining its original semi-liquid condition. Commonly used in channel grooves.

## GLOSSARY - Continued

## S (Cont)

**SEALING GROOVE**--Grooves machined in the faying surface of a fuel tank boundary for injection sealant.

**SEAL PLANE**--All surfaces of a tank which establish fuel seal continuity and are in immediate contact with fuel.

**SECONDARY SEAL**--A seal which by itself will not constitute a reliable primary seal.

**SELF-SEALING FASTENER**--A fasteners which provides a fuel tight seal without the application of sealant.

**SHORE-A HARDNESS**--A measuring scale for the durometer hardness of rubber, cellular, and elastomeric materials.

**STATIC ELECTRICITY**--The accumulation of an electrical charge on a person or object due to friction, wind or induction.

## T

**TACK-FREE**--The condition of a sealant during the curing stage when the sealant will not stick to polyethylene plastic when pressed lightly to the surface.

**TASK**--Any designated work, e.g. inspection, repair, etc.

## T (Cont)

**TEMPORARY REPAIR**--A repair designed to down grade leak classifications to a flyable condition until such time as a permanent repair is applied.

**TOP COAT**--A material applied over the fuel exposed surfaces of some curing type sealants to protect the sealant from deterioration.

## V

**VENTILATION**--The process of supplying air to a tank or cell after a fluid purge.

**VOID SEAL**--A seal used to fill holes, joggles, channel, and other voids caused by the buildup of structure in a fuel tank; and which provides continuity of sealing where fillet seals are interrupted by these structural gaps.

**VOID**--Any opening, small crack or crevice occurring at the juncture of structural members.

## W

**WET INSTALLED FASTENER**--A fastener which is coated on the shank and under the head with a curing type sealant to provide a corrosion barrier and a secondary seal.

**WETTED SURFACE**--Any surface which is in direct contact with fuel.

